# Materials & Methods

THE MAGAZINE OF MATERIALS ENGINEERING ®



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# RYERSON STEELGRAMS

Following are a few paragraphs on the steel situation as we see it here at Ryerson. We hope you will find them helpful in making the most of available steel.

Users of steel from stock get a little help from the current NPA ruling which assures warehouses of some steel. And CMP, expected in July, may use the same warehouse formula for the first few months. The ruling sets up nine months of 1950 as a base period; promises warehouses at least 85% of their average monthly receipts of most carbon steel products during that time. But, of course, this does not mean ample steel for all because: a) There is no separate provision for DO rated tonnage from warehouse — it must be taken from the 85%. b) Volume of this DO rated tonnage is growing steadily. c) General demand continues high. d) The ruling does not apply to alloy and stainless steels.

However, steel users can take the following steps which may prove worthwhile:

1. Whenever possible give us alternate sizes, gauges and qualities that may be used when your exact requirement is not available. Also let us know minimum acceptable length as we may be able to fill your order from "shorts."

2. Extend DO ratings when they apply, because by law we must give rated orders first consideration.

3. Remember that a DO rating can now be applied when ordering limited quantities of most steel products for maintenance, repairs and minor capital additions. (NPA Regulation No. 4.)

4. Keep in touch with us. Remember, our stocks change constantly; so steels we can't supply today may be on hand next time you call.

NPA Order M-14 limiting use of nickel bearing types of stainless can't help but have wide effect among users of Type 302. But Ryerson plants have added stocks of Type 430 sheets. This 17% chrome-alloy stainless resists corrosion in mild form and is a practical substitute for Type 302 in certain applications.

More on stainless changes. Restrictions on use of Type 347 stainless steel require most manufacturers to employ a substitute analysis. Type 321 (stabilized with titanium instead of columbium) has also been added to Ryerson stocks — a satisfactory alternate for 347 in almost all applications.

With defense program scrambling alloy picture, wisdom of buying alloy steels on basis of hardenability as well as analysis becomes more evident. Users forced to work with unfamiliar and leaner types can buy on hardenability with safety from Ryerson because of the Ryerson Certified Steel Plan of testing all alloys in stock — sending hardenability report with every shipment.

Ryerson named exclusive distributor of Rockrite tubing by Tube Reducing Corp. Manufacturers will welcome the closer I.D. tolerance, better I.D. finish of Rockrite for hydraulic cylinder applications. Stocks spotty but we suggest you discuss your application with us.

New Steel Data Book. Just off the press, the new edition of the Ryerson Steel Data Book contains steel specifications and comparisons, tolerances, weight and conversion table — over 250 pages of helpful information. Write for your copy, Dept. 55. Address your nearby Ryerson Plant.

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*(Adv.)*

# The Materials Outlook

Early delays in the effective starting date of the Controlled Materials Plan were not different than expected. Still others can be expected before the plan works smoothly.

Plans are to make the CMP cover all of the supplies of steel, aluminum and copper late this year or next. A truce or peace in Korea will probably not have any great effect, since most leaders are all in agreement that our arms program must continue at a steady pace.

Reports are that our defense output is about 25% behind schedule. Should these reports be correct, any attempt to catch up will have an adverse effect upon the metals supply, because the planned production is about to reach its highest point. This probably explains why last spring's predictions of an early steel surplus have now changed to warning of a long-time famine.

Steel and aluminum production capacity is increasing at such a rate that there is a likelihood of copper being the controlled material that will be the key to the rate of civilian production. Copper, along with lead and other nonferrous metals, is becoming more scarce, relatively, because normal imports are now going to European countries which offer more than the U. S. ceiling price. To offset this situation the Government is contemplating purchase of metals at above ceiling prices—where necessary—and reselling to industry at the established ceiling price. The plan involved is felt to be satisfactory in that it will permit increased imports of scarce metals without cracking the price control program.

A recent report issued by the U. S. Bureau of Mines shows that the greatest consumption of nickel occurs in its use as an alloying element in nonferrous alloys (including monels and nickel alloys). Runner-up for the greatest end use is stainless steel, which during January of this year took almost 3½ million lb; nonferrous alloys took almost 4 million lb.

Any plans for a proposed New England steel mill seem destined for the shelf, at least for another year or two. After several adverse reports on the project, the Connecticut legislation permitted bills necessary to the mill to die without action. A site near New London had been chosen as the ideal location, but legislation was needed to acquire the necessary property.

The situation in the country's tin market presents some interesting paradoxes. Tin is one of the metals in which we are a "have not" nation,

*(Continued on page 4)*

# The Materials Outlook *(continued)*

and this, combined with present skyrocketing prices, might offer a basis for the assumption that tin is in critically short supply. Actually, there would have been a considerable surplus if government stockpiling had not jumped in to take more than a hundred thousand tons off the market, and there is little reason to expect a shortage in the foreseeable future unless the military situation should change greatly and unexpectedly. Present high prices are largely the result of government stockpiling and international speculative buying.

Tin production is high, and steadily going higher. During the war the tin supply from Malaya and the Far East generally was cut off, and Bolivia, which had been a rather small factor in world production, increased its operations. Today it produces about 25% of the world total. Malaya and Indonesia together account for about 50%, Nigeria and Belgian Congo together for about 22%, and Burma, China, Siam, etc., for the remainder. Interestingly, tin is still being recovered from canmakers' scrap in this country, though the tinplate used contains only about 0.8% tin as against about 1.3% for the hot-dipped plate.

When the Japanese seized the world's richest tin-producing areas during the war, the tin dredges were sunk and concentrating plants destroyed. Tin prices were frozen at 52¢ per lb in this country, and use of tin was rigidly controlled. Figures for world production, world consumption, and average prices since then tell an interesting story:

| | World Production of Tin Metal (Long Tons) | World Consumption of Tin Metal (Long Tons) | Average Price (per Lb) |
|---|---|---|---|
| 1946 | 89,000 | 111,700 | 54.58¢ |
| 1947 | 112,000 | 131,000 | 77.94¢ |
| 1948 | 157,400 | 135,700 | 99.32¢ |
| 1949 | 168,300 | 116,600 | 99.15¢ |
| 1950 | 171,900 | 151,400 | 95.56¢ |

It can be seen that as soon as war damage to equipment was repaired, production rose rapidly and quickly overtook consumption.

Average prices do not indicate the full impact of this high rate of production. In June 1950, at the time of the outbreak of the Korean conflict, the price of tin was about 77¢ per lb. Under the influence of government stockpiling and speculative buying, the price rose sharply to about 90¢, then to $1.02 in July, and finally to a high of $1.83 early in 1951. When the U. S. Government stopped stockpiling, speculative buyers also stopped bidding for tin and the price fell to about $1.39. Late in June the RFC price dropped to $1.06 per lb.

While the use of tin is still controlled, there is no reason to anticipate a continuing shortage of the metal after stockpiling requirements have been met. It has been estimated that the stockpile now holds about 110,000 tons, with approximately 65,000 tons more on hand in the country outside of government holdings. It may be expected that, in view of the large and continuing supply of the metal, government restrictions upon its use will shortly be relaxed.

**See page 7 for "Materials Control Orders"**

# Materials Control Orders

*A summary highlighting actions of the NPA affecting engineering materials during the period from May 16, 1951 through June 15, 1951.*

● **ALUMINUM (Orders M-7, M-26, M-50, M-67, M-68)**

Aluminum foil for protective packaging limited to 0.005-in. thickness except when used to fill rated orders. Use restricted to 65% of average monthly consumption by weight during six months ending Dec. 31, 1950 on specified food wrappers and miscellaneous items. Packaging for antibiotics unaffected, while certain items including medical supplies are restricted to lesser degrees. Effective June 1, retailers who must assemble aluminum structures at the point of installation are exempt from limitations on such assemblies. Consumption of aluminum wool permitted at 65% of base period rate. Electric power industry to be allotted 25,000,000 lb of aluminum in third quarter for maintenance and expansion of facilities. Automobile manufacturers can compute their individual total permitted aluminum for third quarter by means of formula set up in M-68. Monthly use limited to 40% of total permitted quarterly use. Bottlers of wines, distilled spirits and non-alcoholic drinks limited to 65% of base period consumption of aluminum closures.

● **CADMIUM (Order M-19)**

Temporary relaxation of controls during third quarter to permit greater use for pigments, plating and automotive purposes.

● **COPPER (Orders M-11, M-16, M-50, M-68)**

**Present Status:** During July the amount of copper and copper-base alloy production which must be allotted to filling rated orders can be summarized as follows: beryllium copper castings—90% of total shipments during base period, all other castings—75% of same; foundry copper and copper-base alloy production—75% of base period production; wire mill products—80% of average monthly shipment of each product during base period, while overall tonnage limitations are set at 75% of tonnage shipped during base period. The base period is changed to the first quarter of 1951. 75,000,000 lb of copper to be allotted to electric power industry during third period for maintenance and expansion of facilities. Automobile manufacturers can compute individual permitted copper allotments using formula set up in M-68. Monthly use of copper for automotive purposes limited to 40% of quarterly use.
**Anticipated Changes:** Toll agreements between fabricators and owners for processing scrap into unalloyed copper will probably be prohibited after Aug. 1. Distribution of refined copper and copper alloy scrap will be placed under complete allocation.

● **GRAPHITE, ARTIFICIAL (Order M-66)**

Commencing July 1 all artificial graphite products and carbon electrodes will be under allocation. Graphite electrodes less than 1 in. in cross section and consumers of less than 500 lb of artificial graphite in the current quarter are exempt. Inventories limited to four weeks supplies except pool car buyers (limited to eight weeks) and users of artificial graphite anodes (limited to 20 weeks minimum supplies).

● **LEAD (Order M-38)**

Starting June 1 dealers must accept 25% of anticipated monthly production of lead products in defense orders. Primary refiners must set aside 5% of anticipated monthly pig production for hardship cases. Except for pig lead, use of lead forms and materials restricted to no more than 100% of average monthly use by weight during first six months of 1950.

● **MOLYBDENUM (Order M-30)**

New order will remove pure molybdenum wires, rods and sheets from regulation under M-30 and set up new instructions for applying for allocations and reporting inventory, production and end-use information.

● **PLYWOOD (Order M-63)**

Soft plywood producers must set aside 20% of average monthly production during the period Oct. 1950 through Mar. 1951 for defense rated orders each month commencing July 1. Rated orders must be placed 30 days in advance of the first of the month in which delivery is requested.

● **RUBBER (Order M-2)**

May rubber order to be continued through the third quarter. Production is permitted at 100% of base period rate of many essential products, 90% of others.

● **STEEL AND IRON (Orders M-1, M-4, M-47, M-50, M-68)**

**Present Status:** Producers must set aside increased percentages of specified products scheduled for defense or defense-supporting industries in July. Pending complete change over to CMP, NPA will continue procedures set up under M-1 during August. Producers must supply steel converters with at least 90% of average monthly tonnage consumed during the period from Jan. 1, 1950 to Aug. 31, 1950, with exception of carbon plate for line pipe. Percentage increases in set-asides of stainless steel products for defense range from 25 to 100%. Construction of any project requiring greater than 25 tons of steel not covered by lists of M-4 must receive NPA authorization. Auto manufacturers may use up to 40% of permitted quarterly use in any one month. Starting July 1, use of iron and steel on most consumer durable goods is limited to 70% of base period consumption. Manufacturers must fill DO orders from 70% quota. Users of less than five short tons of carbon steels and 1000 lb of alloy (except stainless) steels are exempt from 70% limitation; those using less than 100 short tons may use 90% of base period consumption.
**Anticipated Changes:** Use of high-speed and tool steels containing tungsten and molybdenum in hand tools will be prohibited.

● **TIN (Order M-25)**

**Present Status:** Unlimited use of 0.25 tin plate now permitted to coat small dry whole milk cans and containers of products with dry milk base until July 31. Five-gal or 50-lb containers for dietary dried milk base products may now receive unlimited 0.50 tin plate coatings.
**Anticipated Changes:** Steel for tin plate expected to have increasing influence on tin mill products during latter half of year.

● **TUNGSTEN (Order M-30)**

New order will remove pure tungsten wires, rods and sheets from regulation under M-30 and set up new instructions for applying for allocations and reporting inventory, production and end-use information.

● **ZINC (Orders M-9, M-15)**

Producers of special high grade slab zinc must accept DO orders for up to 20% of anticipated monthly production. Starting June 1, producers and importers of slab zinc required to set aside 5% of anticipated monthly production and imports to meet emergency requirements. Civilian consumption of special high grade slab zinc restricted to 70% of average quarterly use during first six months of 1950. With certain exceptions, consumption of all other types of zinc restricted to 80% of user's average quarterly consumption during base period. Inventories limited to 30-day supply.

**WELDING HERCULOY** *plates into a hot water storage generator for the new Veterans' Hospital in Boston.*

**ROLLING HERCULOY** *plates into cylindrical form for the tanks. Photos from The Patterson-Kelley Co., Inc., East Stroudsburg, Pa.*

Once Again—

# HERCULOY

## is Chosen for Hot Water Storage Generators

**HERCULOY** is Revere's Copper-Silicon Bronze, which has the corrosion resistance of copper plus the strength of mild steel. It is therefore ideal for hot water tanks, among many other applications. Much has gone into domestic water heaters, but these are far outstripped in size by a number of large tanks fabricated of Herculoy by The Patterson-Kelley Co., Inc., East Stroudsburg, Pa., for the new Veterans' Hospital in Boston. The water is heated by steam passing through bundles of Revere Phosphorized Copper Tube. Inlet and outlet flanges are Herculoy, made from heavy gauge extruded shells, which offer economies over the alternative method of cupping them out of plate.

Patterson-Kelley weld all these large storage heaters, using Heliarc. Easy weldability is another important quality of Herculoy. Golden beauty is also a feature, and the size and beauty of these tanks created a great deal of comment while they were being trucked to the hospital. . . . Remember Herculoy's qualities: corrosion resistance of copper, strength of mild steel, easy weldability and formability, and beauty. Remember other applications besides tanks, such as: vats, screens, filters, ducts, fire extinguishers, chemical and marine construction.

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# News Digest

## Annual SPI Meeting Discusses Defense Problems

The problems of materials supply, pricing and defense uses of plastics claimed the attention of the more than 450 members of the Society of the Plastics Industry who attended the annual meeting held May 24 and 25 at The Greenbrier, White Sulphur Springs, W. Va. The attendance was said to be the largest ever to be attained at an annual meeting.

Most of the two-day business session was devoted to those problems which have arisen as a direct result of the nation's defense program and to listening to reports of the use of plastics in military and naval equipment. Other business included the election of national officers and the presentation of the John Wesley Hyatt Award during the annual banquet.

### Military Uses

In commenting upon the military uses of plastics, Dr. Warren Stubblebine, Research Director, Chemicals and Plastics Section, Research & Development Branch, Office of the Quartermaster General, Department of the Army, indicated that the Army was going to great lengths to make certain that plastics were used properly in goods and equipment for the Army. Some questionable uses could result, Dr. Stubblebine said, because most plastics molders acted in the role of subcontractor and, therefore, had little chance to make recommendations as to the suitability of materials in their ultimate applications.

The Army is investigating many uses of vinyls both as films and as fabric coatings for applications which would replace paper and textiles. Dr. Stubblebine reported that some false reports of shortages had kept plastics from certain applications but that these cases were being cleared up and advantage taken of the properties of plastics. One example of this situation was the use of polystyrene spoons. At present there is no expectation that plastics bugles will make a reappearance, nor are plastics uniform ornaments expected soon.

With the development of standards for melamine-phenolic tableware, it is expected that large quantities of these materials will be used in Army installations throughout the world. Extensive use is being made of the low pressure laminates for such items as typewriter cases, sled boats, locker trunks and packboards. Many other uses of this material are now under tests, and it is expected that several new uses will be developed for military applications in future months.

### Naval Uses Keep Pace

The use of plastics in naval applications has kept pace with the general growth of the industry, the meetings were told by Dr. Albert Lightbody, Chief, Chemistry Division, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

The combination of lightness and strength in plastics materials has made them particularly welcome to the Navy for use on ships, since the lightness can help Naval designers reduce the overall weight which must be carried above the ship's deck.

Dr. Lightbody pointed out that the military services are slow to adopt new materials, particularly in peacetime, but will accept newer materials after they have been proved in industrial application. Thus, he said, it is not unreasonable to expect soon to find plastic decking, masts and hulls—and, someday, even plastics used extensively in the ship's propulsion equipment. Naturally, plastics are now being used in ever increasing quantities in the shipboard electrical equipment, which is becoming more and more complex.

### The Supply Picture

Members of the industry were given some information on the materials supply situation for plastics by representatives of the thermosetting materials manufacturers, the thermoplastics manufacturers, and a representative of the National Production Authority. Representatives of the materials groups did not hold out too much hope for greatly increased capacity for plastics in the near future. Shortages of chemicals, constructional materials and manpower all make difficult the adding of capacity. In addition, the cost of building manufacturing plants today acts as a damper on expansion plans.

As conditions now stand, the plastics industry is producing resins of all types at a rate that is more than double the rate of 1945. The estimated production during 1950 amounted to 1,650,000,000 of synthetic resin.

Unless 50% of the production of a specific plastics material is required for military and defense uses, the National Production Authority does not plan to issue control orders covering the materials. Currently four plastics are subject to control to assure a sufficient quantity for defense purposes. The first to be controlled was polytetrafluorethylene, followed by plastic type nylon. Polyethelyne was placed under control June 1, and it is considered possible that ethyl cellulose might go under control next. Presently about 40% of the supply is being used on DO production.

*(Continued on page 10)*

# News Digest

### Hyatt Award Made

At the annual banquet of the society, Gov. Okey L. Patterson, of West Virginia, presented the tenth annual John Wesley Hyatt Award to James Bailey, of the Plax Corp. In addition to a gold medal, the winner also received a check for $1,000. The award was granted Mr. Bailey for the work he has done in developing plastic bottles, sheet and film for packaging, and extruded plastic tubing. The award is sponsored by the Hercules Powder Co.

### Officers Elected

In the election of officers for the ensuing year, Gordon Brown, vice-president, Bakelite Div., Union Carbide and Carbon Corp., was named president of the society. Horace Gooch, Jr., Worcester Moulded Plastics Co., the immediate past president, was elected a director and chairman of the board. Other officers are: Dale Amos, Amos Molded Plastics, director and vice-president; and J. E. Gould, Detroit Macoid Co., director and secretary-treasurer.

## Oxy-Argon Mixture Increases Speed of Inert-Gas-Metal Arc Welding

A new principle to increase the speed of inert-gas-shielded metal arc welding of stainless and carbon steels has been announced by Linde Air Products Co., a division of Union Carbide and Carbon Corp. Unusual results have been obtained by use of a mixture of oxygen in argon as a shielding atmosphere. They propose to name this method sigma welding.

*The relative size of the drop of metal being transferred shows that more, but smaller, drops are formed in the special argon atmosphere, shown at left, adding to the inherent stability of the arc. During the time of a full cycle of droplet formation in a pure argon atmosphere, at the right, some 50 droplets will have been deposited in the special grade argon atmosphere. The weld bead is generally wider and flatter in the special gas atmosphere than the narrower and higher weld bead in the pure argon atmosphere.*

Earlier research had established that, for best welding conditions, metal transfer consists of a series of discrete metal droplets propelled at a high velocity. Droplet formation will vary with different metals and for different current densities.

Recent investigations by Linde have shown that the droplet rate, particularly on stainless and carbon steels, can be materially increased by the addition of small percentages of oxygen to highly purified argon. Droplet rate in this oxy-argon mixture has been as much as 50 times greater than in an atmosphere of pure argon, other conditions being the same.

This greatly increased droplet rate, with no change in current density, permits welding at higher speeds without undercutting. Coalescence of the weld metal is improved at increased welding speeds, and overhead welding of stainless steel is made practicable.

On the other hand, the oxy-argon mixture permits welding at lower current densities. This means that larger diameter, more economical rods can be used for a given welding current. If the same size rod now available is used, then thinner materials can be welded.

Use of this special argon is expected to expand the application of sigma welding on stainless steel because of improved economy, and ability to perform welding operations not practicable with straight argon. Likewise, on carbon steels, increased applications of this method can be expected as welding speeds can be at least doubled, gas consumption correspondingly reduced, and less expensive welding rod used.

## Manganese Recovered from Steelmaking Waste

A miniature blast furnace at Pittsburgh, working with slag, the waste material of steel production, may prove to be one of the most important furnaces in the country, according to American Iron and Steel Institute. This furnace, 16 ft high, started operating early in March in an attempt to recover the manganese in slag from open hearth furnaces.

Research on manganese, an essenital element in steelmaking, has been intensive in recent months to avert possible domestic shortage if foreign sources of supply are drastically reduced. Some research metallurgists believe that an estimated 440,000 tons a year of manganese may be found in this country in economically recoverable open hearth slag. That tonnage is equal to approximately 68% of the amount used in steel manufacturing during 1950.

The small blast furnace is intended to simulate conditions in a commercial structure in attempts to remove undesirables, such as phosphorus, from the open hearth slag. If the theory being tested at Pittsburgh proves practical, a useful ferroalloy containing 80% manganese will be produced.

Other methods of recovering manganese from slag are being studied at College Park, Md., and a third project, sponsored by steel companies through the American Iron and Steel Institute, may soon be undertaken.

## Materials Papers Presented at ASTM Meeting

Seven formal technical symposiums on important subjects in the field of materials engineering were held at the American Society for Testing Materials meeting in Atlantic City, June 18 to 22, and a number of technical papers were presented in coordinated sessions.

The session devoted to fatigue and nonferrous metals heard a paper by J. T. Richards, R. K. Levan and E. M. Smith, of the Beryllium Corp., on the influence of cold work and heat treatment on the engineering properties of beryllium copper wire.

In the same session, the preliminary results of fatigue tests in axial compression were presented by N. M. Newmark, R. J. Mosborg, W. H. Munse and R. E. Elling, of the University of Illinois. Studies on the effects of repeated compressive loading on gray cast iron, 24ST aluminum and structural steel were made. In general, compressive failures occurred only under high stresses. In A7 steel, for example, failures were not observed at less than five million cycles until stresses in the neighborhood of 85,000 psi or higher were applied. These results, under nearly uniformly distributed axial compressive loads, are in distinct contradiction to results obtained with notched specimens or with repeated bending tests.

The ASTM, in the face of the growing need for standard test methods and specifications for structural sandwich constructions, set up a committee to handle this work. The symposium arranged by this committee heard a number of interesting discussions of various phases of the new configurations.

Structural sandwich constructions, as usually employed, consist of laminated materials in which the faces are relatively thin, strong and dense, whereas the cores are relatively thick, light, and considerably weaker than the faces. The more or less obvious objective is to obtain a structure which is strong and stiff because of its construction, but is at the same time light in weight, or has other desirable attributes not obtainable with the components alone.

A brief survey was made by H. W. March, of the Forest Products Laboratory, of a selected group of problems concerned with the elastic behavior of sandwich construction. These include the wrinkling of the facings under compressive load and the effect of shear deformation in the core on the deflection of uniformly loaded panels and on the buckling loads of panels subjected to edgewise compression or shear.

A number of modes of failure that are peculiar to sandwich construction were described and their relations to allowable stresses and allowable loads discussed in a paper by Charles B. Morris, of the Forest Products Laboratory. For purposes of simplicity and brevity, the discussion was limited to strips of sandwich construction loaded as beams or columns.

The next author, George Gerard, from New York University, discussed the compressive and torsional instability of sandwich cylinders.

A review of a theoretical and experimental program on the buckling behavior of sandwich cylinders was presented and the two types of instability which can occur for a sandwich element were considered. One involves buckling of the sandwich element as a unit, while the other is concerned with the buckling of the faces upon the core—commonly referred to as wrinkling. Both were considered theoretically for the sandwich cylinder under compressive and torsional loadings, and experimental data on buckling loads and buckle patterns were then offered to substantiate the theoretical results.

Another phase of the field was considered by T. P. Pajak, of the Glenn L. Martin Co. Aluminum honeycomb core material has outgrown the experimental stage and is used on production structures. The combination of aluminum facings, aluminum core, and a special adhesive gives structural material with high strength and rigidity. The advantages of the aluminum honeycomb core material are uniform density, high specific strength, high shearing modulus, and resistance to environmental effects with constant

*(Continued on page 13)*

## News Digest

Matter of Fact
BY EDWARD A. JOSEPH
CLYOLITE, A SOLVENT USED IN THE ELECTROLYTIC PRODUCTION OF ALUMINUM, ALSO IS USED AS AN INSECTICIDE IN WARDING OFF HORNWORMS FROM CERTAIN TYPES OF TOBACCO
AT ABOUT FIVE OUNCES TO A PAIR OF CLEATS, TOTAL WEIGHT OF STEEL IN BASEBALL SPIKES HAS BEEN ESTIMATED AT SEVEN TO EIGHT TONS
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Pioneer in the development of stainless steels, Crucible is casting these high quality fittings in Types 304, 316 and 347 stainless. Made under the most exacting metallurgical supervision and radiographic control, these castings are entirely free of porosity, internal shrinkage, or other casting defects. The castings are furnished annealed, blast cleaned and passivated for maximum corrosion resistance.

The high casting quality plus the particularly husky design make the Alloy Stainless Products' pipe fittings among the leaders in the field.

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## News Digest

strength under variable humidity and temperature conditions.

The strength of aluminum honeycomb core varies directly with the density of the core regardless of the various combinations of cell sizes and foil thicknesses. Standardization of cell size has resulted in volume production of core material and increased applications. Proper design and fabrication process control are required to achieve satisfactory results. An impressive variety of aircraft parts has been made of aluminum core, and recent trends indicate that an increasing percentage of new airframe designs are utilizing aluminum honeycomb sandwich construction.

Fabrication techniques for structural sandwich constructions were covered by Bruce G. Heebink, of the Forest Products Laboratory.

The discussion featured the fabrication of lightweight sandwiches for aircraft applications, such as wing coverings, floors, shear webs and radar antenna housings.

Consideration was also given to fabrication of sandwiches for housing, furniture and transportation applications. Such widely different materials as glass cloth, metals, plywood, and paper for facings, and cores of solid wood, metal honeycomb and synthetic resin foams were included. Bonding processes for the currently available metal-to-metal adhesives and low-pressure resins were discussed, and the various means of applying pressure and heat, including fluid pressure, and the limitations of each were presented.

### High Strength Aluminum Alloy for Airplanes

The Aluminum Co. of America has developed a strong new aluminum alloy which is specifically intended, at least for the present, for use in military aircraft to cut weight and give heavier bomb loads, greater speeds and longer ranges. Alcoa says that the new alloy is 10% stronger than the highest strength aluminum alloy now in use.

The product of several years' cooperative research by Alcoa, the United States Army and Navy air

*(Continued on page 142)*


How's this for STRENGTH?

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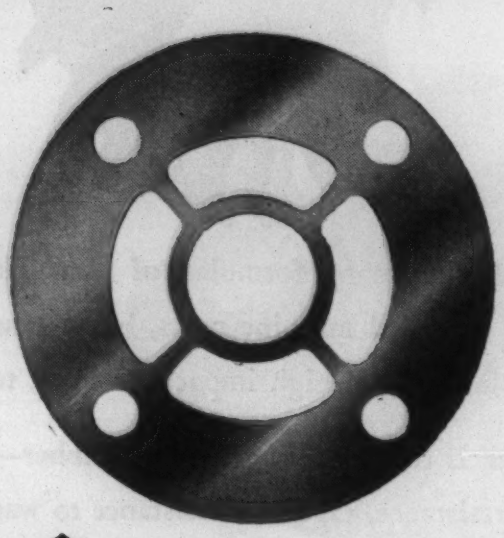
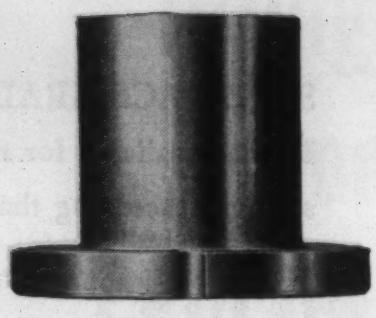
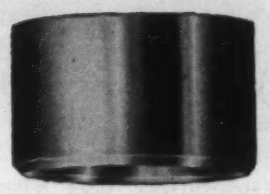


Gasoline meter valve-seat formerly made of bronze.

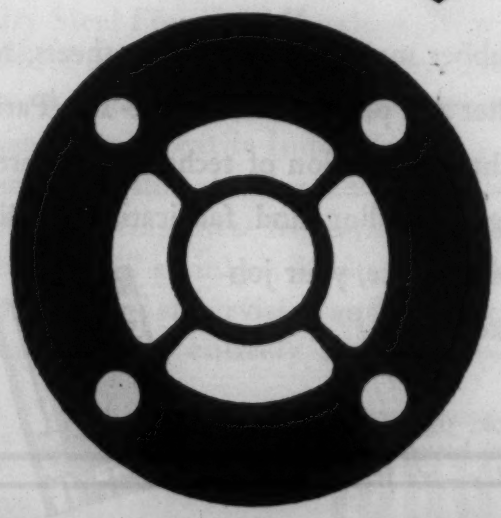


Former copper — tin — lead industrial bushing.

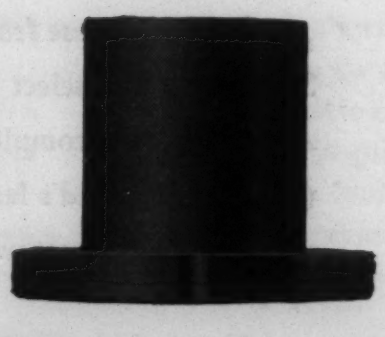


Piston, previously cast and machined from aluminum.

New valve-seat, now made of weight-saving Graphitar.



New bushing identical in size, shape and with better performance now made of Graphitar.



New Graphitar piston .of equal lightness which is giving improved performance.

# THE UNITED STATES

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Marvinol comes from the Naugatuck Chemical Division of the United States Rubber Company — a basic source of raw materials. It's in the plastics business to *stay* and *grow* with you. Write us and see what Marvinol can do for *you.*

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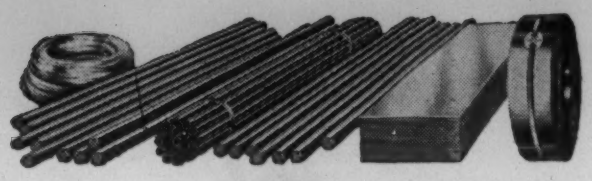


BRIDGEPORT BRASS COMPANY

# COPPER ALLOY BULLETIN

"Bridgeport" BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Continuous Casting of Brass at Bridgeport Brass Co., Bridgeport, Conn.

## Brass Scrap Situation and Its Effect on Brass Production

Copper and zinc, essential metals for both military and civilian needs, have been in short supply for many months and the situation has been growing worse. After taking care of the mounting volume of DO orders, there is not enough remaining to take care of civilian needs even at the reduced allotment.

As far as we can learn, there has not been a sufficient increase in the production of copper and zinc to satisfy this unprecedented demand and to take care of the requirement of the government stock piling, defense and foreign rearmament programs.

The high volume of production of brass mill products during 1950 and the early part of 1951, has been possible only because the mills have dipped into their metal inventories which are at their lowest ebb today.

From the brass mill standpoint, the short supply of zinc has been critical because it is needed for alloying with copper to produce brass. Zinc acts as a means of stretching the available supply of copper because when alloyed with 100 pounds of copper it can result in about 145 pounds of brass. This increased tonnage will serve a larger number of users.

However, to augment the supply of zinc and copper, the brass mills use clean brass scrap, viz., clippings, rod ends, and shavings generated during metal goods fabrication. The scrap is added to the melt with new metal and is eventually turned into new mill products.

It has always been the custom for the brass mills to buy back the brass scrap from their mill products, customers and metal dealers at definite published prices which reflect the prevailing prices of new copper and new zinc.

Today, because of the voracious demand for brass scrap, its price has been raised considerably beyond that of virgin metal. As a result, a portion of this scrap, which would ordinarily be returned to the brass mills, has been diverted to other channels.

The serious shortage of copper and zinc, plus the insufficient brass scraps being returned to the mills explains in part why the brass mills are operating on a reduced schedule and are not able to fill the many orders which have piled up.

### Some Scrap Diverted

The scrap situation can be improved if metal goods manufacturers will make sure that *all* their scrap is returned to the brass mills. Although most manufacturers make it a practice to do so, there are some smaller ones who think that their scrap generation is insufficient to count. However, when the scrap generation of all small manufacturers are added up, the total becomes worthwhile.

It is true that in some cases brass scrap can fetch higher prices than that offered by the brass mills. Unfortunately, if this scrap does not find its way back to the brass mills, the brass mill tonnage is reduced and all brass users suffer.

### How Brass Users Can Help

Here are a few suggestions which, if followed by metal goods manufacturers, would help the scrap situation considerably.

1. Store all scrap in clean containers, keeping it separated by alloy and properly identified.
2. When a sufficient quantity has been collected, notify the brass mill for whom it is intended. Give details as to weight, alloy, character of scrap. Ask the brass mill to collect it either in their own trucks or to designate the particular scrap dealer which does this work for the brass mill.
3. If you know where there are clippings of zinc resulting from manufacturers' cups or stampings, or scrap copper wire or other forms of good clean scrap of brass, bronze or copper not generated by brass goods manufacturers, please notify your supplier of brass mill products. (6867)

# The Present and Future of Nickel and Cobalt

by CHARLES A. SCARLOTT, Westinghouse Electric Corp.

***Nickel and cobalt are two of our most important strategic metals. Although they are at present critically scarce, the long-range prospects for both are good.***

● NICKEL AND COBALT have much in common. Both earned their names because they were nuisances. Nickel was Kupfer-Nickel (Old Nick's Copper) because it occurred with sought-after copper and played havoc with early methods of processing copper ore. Kobold—a mischievous spirit—was so named because ores containing it emitted troublesome and dangerous fumes, later proved to be associated arsenic. Now nickel and cobalt are earnestly sought. Both are growing in peacetime importance. In any defense program both are essential. They generally are found together in the mines. When one is mined, the other often comes along as a by-product. In fact, they are so much alike chemically that separation is difficult. While many of their uses are completely dissimilar, they often are teamed as alloying agents. And finally, production of each in the United States—the largest consuming country—is small. There are no known nickel deposits in the United States that could compete with the rich deposits of Canada and New Caledonia, but cobalt has brighter prospects.

## Nickel Production

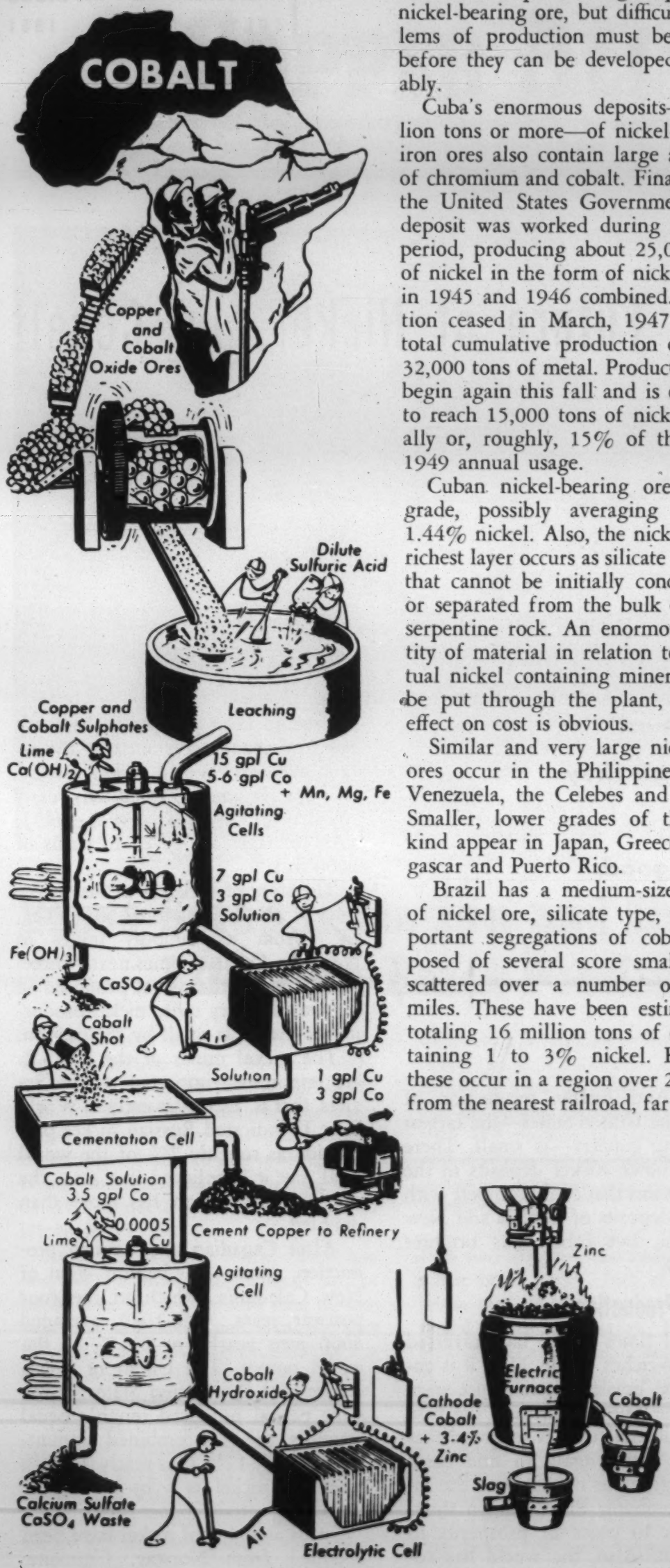
Several times nickel has traversed a "rags-to-riches" cycle. Now it is enjoying the greatest success, use-wise, it has ever known. Further, the base of its industrial uses is so broad that it is not likely again to find itself going begging as it has when the industrial economy made sudden shifts from war to peace or prosperity to depression. Also, the world has copious quantities of nickel, although production facilities are being hard pressed to keep pace with the sharp rise in demand occasioned by the affair in Korea. World nickel production has averaged 155,000 tons yearly since World War II (1945-1949). (All tonnages are given in terms of 2000 lb.)

The story of nickel is primarily the story of The International Nickel Co., Inc. From its Sudbury mines in Northern Ontario comes nearly three-fourths of all the nickel produced in the world. Every other nickel-producing operation is small by comparison.

The nickel mines of the U.S.S.R. are important—important to the Soviets, that is. Estimates early in World War II indicated Russian nickel production as roughly 7% of the world total, but it is believed that since the war this proportion has more than doubled.

After Canadian and Russian production, comes—far behind—that of New Caledonia, which in the four postwar years, 1946-1949, averaged 4000 tons yearly, or 2½% of the world output. The Union of South Africa and the United States in the same period produced roughly equal amounts, the two combined amounting to barely 1250 tons yearly. In both cases the nickel is a by-product of processing certain copper ores.

Small amounts of nickel have been obtained from Norway, Germany, Finland, Greece, Burma, India and Japan. Cuba, Brazil, Venezuela, the




How cobalt is produced.

Philippines and the Dutch East Indies are known to possess large deposits of nickel-bearing ore, but difficult problems of production must be solved before they can be developed profitably.

Cuba's enormous deposits—3 billion tons or more—of nickel-bearing iron ores also contain large amounts of chromium and cobalt. Financed by the United States Government, this deposit was worked during the war period, producing about 25,000 tons of nickel in the form of nickel oxide in 1945 and 1946 combined. Operation ceased in March, 1947 after a total cumulative production of about 32,000 tons of metal. Production will begin again this fall and is expected to reach 15,000 tons of nickel annually or, roughly, 15% of the 1946-1949 annual usage.

Cuban nickel-bearing ore is low grade, possibly averaging about 1.44% nickel. Also, the nickel in the richest layer occurs as silicate minerals that cannot be initially concentrated or separated from the bulk of waste serpentine rock. An enormous quantity of material in relation to the actual nickel containing minerals must be put through the plant, and the effect on cost is obvious.

Similar and very large nickel iron ores occur in the Philippine Islands, Venezuela, the Celebes and Borneo. Smaller, lower grades of this same kind appear in Japan, Greece, Madagascar and Puerto Rico.

Brazil has a medium-size deposit of nickel ore, silicate type, with important segregations of cobalt composed of several score small bodies scattered over a number of square miles. These have been estimated as totaling 16 million tons of ore, containing 1 to 3% nickel. However, these occur in a region over 200 miles from the nearest railroad, far removed from a labor supply, and with neither coal nor, at present, water power for ore processing. A larger but lower grade deposit of this type is known in Venezuela where mining and transportation conditions are more favorable, but the low nickel content and the silicon present a difficult problem.

The only nickel ore within the United States that seems to offer major prospects at present is the Riddle deposit in Oregon. It is a silicate ore such as occurs in New Caledonia, but of lower grade. It has been roughly estimated at 40 million tons of 1 to 2% nickel. The M. A. Hanna Co., with encouragement and technical assistance from the U. S. Bureau of Mines, is studying the feasibility of its development. There are also some nickel-cobalt deposits in the vicinity of Fredericktown, Mo.

Although copper ore was identified in the wilderness near the present town of Sudbury in 1856, it was not until 1863 that construction crews blasting a westward route for the Canadian Pacific Railway uncovered evidence of the enormous Sudbury ore body. Actual mining operations of the Canadian Copper Co., a forerunner of The International Nickel Co., Inc., began in 1886. The presence of nickel was not suspected until the first ore had reached the Bayonne, N. J. refinery, whereupon it manifested its presence by refusing to be separated from the copper. The Sudbury ores seemed doomed.

But some Sudbury-ore sponsors refused to give up, and out of their labors came the Orford process. Addition of sodium sulfate to the molten mixture was found to cause the nickel sulfides to separate and settle by gravity from those of copper. (Later the Mond process was also developed.)

## Nickel Consumption

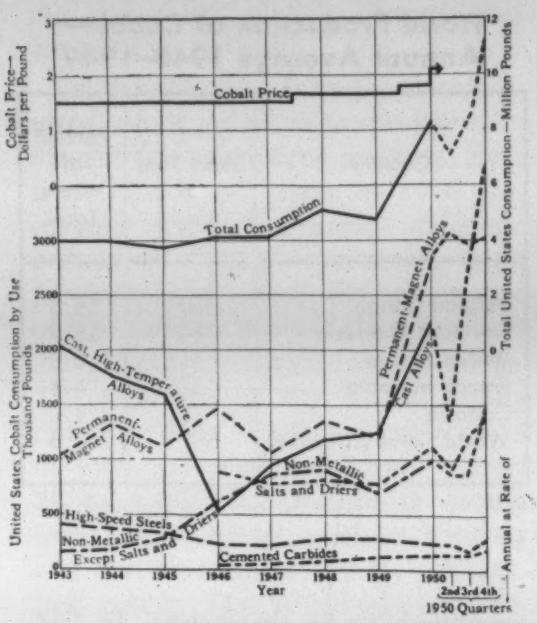
Now the problem became what to do with nickel. By 1900 consumption totaled only 4000 tons per year. Sudbury ores alone could produce twice that much. Word came of a French discovery that addition of nickel to steel improves it toughness. The nickel producers, after trying without success to sell the idea to Krupp of Germany, induced the Secretary of the United States Navy to subject ordinary armor plate and nickel-steel armor to competitive test under the impact of six-inch shells. The superiority of nickel steel was indisputable, with consequent placement of large orders for nickel—more, in fact, than the company was prepared immediately to provide.

During the first two decades of this century the demand for nickel developed rapidly, due principally to its use in armament. In World War I, it had climbed to 50,000 tons in 1918 (and by then the 80% position of Sudbury nickel had become established). But with the war over and permanent world peace in prospect, nine-tenths of the nickel market disappeared.

A fresh start had to be made; it became vitally necessary to explore the field of non-military production and develop new uses for nickel. Three things led to phenomenal success. Metallurgical experience during the war with nickel steels provided a great fund of knowledge about these materials. Also, the growing mechanization of industry was calling for heavier loads, higher speeds. Nickel alloying could help solve these more rigid demands on machinery. The automobile industry also had begun its rapid growth. As a consequence, nickel quickly recovered from its loss of armament markets. By 1929 it had reached a production peak of about 60,000 tons. This rise was interrupted only briefly by the depression of the 30's, so that by 1939 production had topped 130,000 tons. World War II skyrocketed nickel demand to 180,000 tons per year, which fell back to an average of almost 155,000 tons in the 1946-1949 period. And now we have another rearmament period, with stock pile, military and civilian demand all together calling for more nickel than production facilities can comfortably produce.

There is, however, no permanent nickel shortage. Extensive deposits, as mentioned, exist in many parts of the world, albeit many are fraught with various combinations of problems of grade, metallurgy, transportation, fuel, etc. The true extent of the great Sudbury deposit is still not known. Its proved ore reserves at the end of 1938 were 212 million tons (6.8 million tons of nickel-copper content). The report for 1950 gives the figure as 253 million tons (with 7.7 million tons of contained nickel and copper). In the interim some 1.4 million tons of nickel alone have been produced from the Sudbury deposit.

Efforts to find different, non-military uses for nickel have met with astonishing success. More than 3000 different alloys with other metals are commercially available, so only major categories can be listed. Nickel alone, and in myriads of combinations with chromium, molybdenum, vanadium and copper, is used for making alloy steels. The austenitic stainless steels, such as the familiar 18:8, are widely



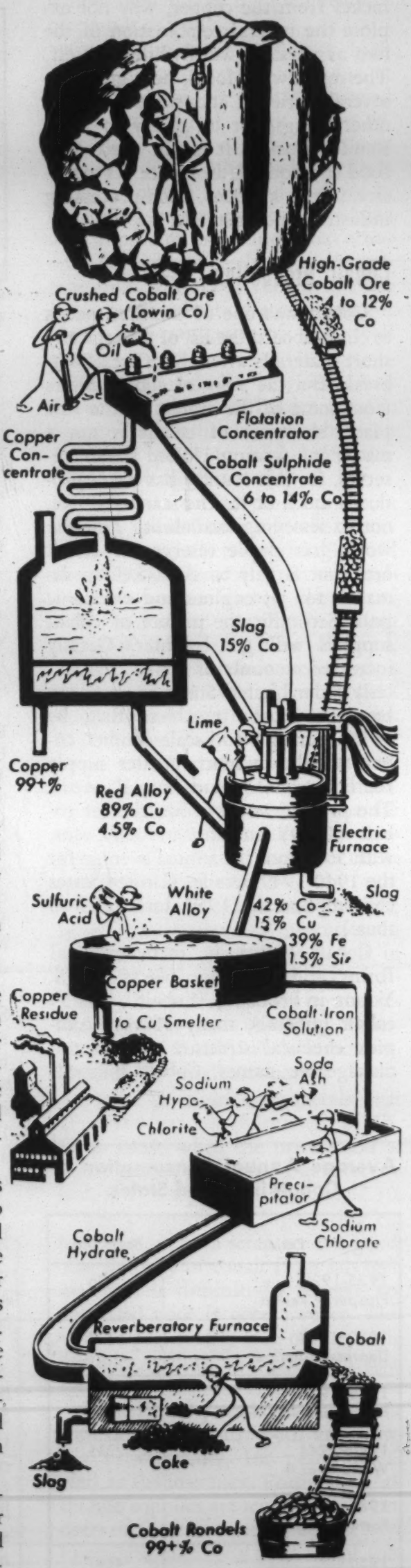

**Price and consumption of cobalt from 1943 to 1950.**

employed in the home, in architectural applications, and in food handling, chemical and petroleum processing equipment and in railroad passenger cars. More highly alloyed, sometimes complex types are used for heat resisting applications in industrial furnaces, internal-combustion engines, gas turbines and jet engines, where strength and resistance to scaling and chemical attack at high temperatures are necessary. Nickel by itself and in combinations with chromium, vanadium, manganese and molybdenum is used in steel castings. Foundries add nickel in making cast iron. Copper and brass mills and brass and bronze foundries alloy nickel with copper, tin and zinc. Nickel-aluminum alloys are used in aircraft engine pistons and cylinder heads.

Nickel has great versatility in the electrical field. It is used for both magnetic and nonmagnetic alloys, for permanent magnets, for controlled-expansion alloys, as the basis for the Edison alkaline storage battery, and for many electrical resistance elements.

Nickel and nickel salts are used as catalysts in the production of soap and edible oils, various chemicals and dyes, in gas purification, and in the manufacture of high-octane motor fuel. The ceramic industry employs it in enamels and as a coloring agent. Large quantities of the metal are used for electroplating to obtain corrosion resistance and bright appearance, where it is generally employed as an undercoat to chromium on plated articles.

Monel has an interesting background. During the search after World War I for new uses it occurred to Mr. Robert C. Stanley, of The International Nickel Co., Inc., to do what




**How nickel is produced.**

now appears to be an obvious thing. Instead of trying so hard to separate nickel from the copper, why not explore the natural combination of the two as an alloy worthwhile in itself. The result was Monel, now grown to several varieties and prized, among other things, for its ability to withstand corrosion. It is not affected by food and body acids. Hence, its extensive use in kitchens, food-processing industries and hospitals.

## Cobalt Production

Cobalt was one of the first metals to climb aboard the list of strategically short materials after the Korean outbreak. But the story of cobalt differs from some of the others. In the first place, shortness of cobalt is not a matter of waning United States reserves, for this country has never produced much of it. The scarcity is due, not to lessening availability (for the world has ample reserves of cobalt ore) but largely to skyrocketing demands for jet engines and electronic gear. Secondly, the picture of cobalt supplies will get brighter. Greatly increased amounts of cobalt, particularly from United States sources, can be expected. So much so that, by 1953, barring a full-scale conflict, cobalt will be in much greater supply for both defense and normal needs. The present world production of cobalt (1949) amounts to 6500 tons, with 5000 tons the annual average for the 1940-1949 decade. (United States consumption in 1950 totaled 4120 tons.)

Cobalt occurs in many mineral forms and in many places. R. S. Young in his book, "Cobalt", lists 59 cobalt minerals, many of very complex chemical structure and of unmanageable names. Cobalt minerals seldom occur by themselves. In fact, cobalt is seldom mined for itself alone. It is associated in a wide range of proportions and combinations with ores of iron, nickel, copper, silver, bismuth, antimony, manganese, lead, zinc, and others. The mineral itself is generally of three forms: in chemical combination with arsenic it is often mixed with ores of nickel, silver and gold; with sulfur it is found with lead, zinc and copper; and in oxide form it is generally accompanied with copper.

**Average Annual Consumption of Cobalt in United States**

| Period | Short Tons |
|---|---|
| 1925-1929 Prosperity Period | 376 |
| 1930–1934 Depression Period | 327 |
| 1935–1939 Post-Depression Recovery | 839 |
| 1940–1944 World War II | 2223 |
| 1945–1949 Postwar Recovery | 3255 |
| 1950 | 4140 |

**World Production of Cobalt— Annual Average 1940–1949**

| Country | Short Tons | Percent of World Total |
|---|---|---|
| Belgian Congo | 3007 | 59.5 |
| Northern Rhodesia | 806 | 15.9 |
| United States | 317 | 6.3 |
| French Morocco | 222 | 4.4 |
| Canada | 213 | 4.2 |
| World Total (Estimate) | 5071 | 100.0 |

The Congo presently accounts for three-fourths of the world total. All Congo cobalt is produced by Union Miniere du Haut-Katanga, which has been increasing output almost consistently for the last 15 years. Northern Rhodesia is now a poor second, with about 7% of the total, although at one time it ranked with the Congo. When a new electrolytic cobalt refinery is completed in late 1951, production is expected to increase to 1500 tons annually. Canada, United States and French Morocco produce roughly similar amounts or, combined, not quite 15% of the world total. The remaining 5% is scattered in traces from Australia, Bolivia, Burma, Chile, Finland, Italy, Japan and Sweden. Russian production was quoted in 1939 as amounting to 550 short tons, or about 10% of world production at that time. It is believed that, by expanding old operations and with new discoveries, the U.S.S.R. is self sufficient for military uses, cobalt-wise.

The only recent United States production of commercial cobalt has been as a by-product of Bethlehem Steel Co.'s magnetic-iron-ore operation at Cornwall, Pa. Here cobalt occurs in a sulfide form. The iron ore, containing a little less than 1 lb of cobalt per ton, is magnetically separated from the cobalt-bearing minerals, and a concentrate averaging about 1.3% cobalt is produced and sent to the Pyrites Co. of Wilmington, Del., for processing to metal and other cobalt products. The 1949 production was 256 tons of contained cobalt, or less than one-tenth of United States consumption that year. However, production of cobalt from Cornwall ores is geared to iron recovery and is not likely to become much greater.

The United States, however, has other cobalt deposits. Sporadic attempts have been made to win cobalt from ore at Fredericktown, Mo., where it and nickel occur with sufides of lead, iron and copper. But, complexities of the ore always introduced such serious difficulties in milling and smelting that efforts ceased in 1946. However, the Chemical Construction Co., a subsidiary of American Cyanamid, has recently developed a new process, not yet described, by which cobalt can be won from the Fredericktown ores. The process is expected to be in operation in 1951. According to estimates, this will augment United States supplies by about 400 tons annually.

Trace amounts of cobalt ores have been obtained from Oregon, Nevada and Arizona. Also, a small amount has been produced as a by-product in the flotation of talc at Burlington, Va.

The great hope for a significant increase of cobalt from within our own borders is at the Blackbird mines of the Calera Mining Co., near Forney, Idaho. This is an underground occurrence of cobalt and copper sulfides whose presence has long been known. The ore body is large, the percentage of cobalt running about 0.6 to 0.8 and twice that much copper. Separation of cobalt mineral from the rock and from the copper mineral and final reduction to metallic cobalt has presented stubborn technical difficulties. The Bureau of Mines has, since 1942, endeavored to develop a technique for processing Blackbird ores. It has made considerable headway. The Howe Sound Co., parent of Calera Mining, became interested in 1943 and sponsored an extensive research program with such favorable results they are building facilities for large-scale operation, which are planned to begin late in 1951. Urged by the government, Howe Sound has expanded its original production plans and now expects to be able to produce a little more than 1500 tons of metallic cobalt per year (about two thirds of 1949 United States consumption).

At the Blackbird mine two concentrates—one containing about 20%

cobalt and the other about 25% copper—will be obtained by a remarkably sharp differential flotation. Both concentrates will be shipped to Salt Lake City, where the copper concentrate will be processed in the Garfield smelter of the American Smelting and Refining Co. Cobalt concentrate will be treated in a new plant being built by Calera Mining Co. by a chemical process not yet published.

It is anticipated that cobalt will be available to the United States in the following quantities annually: Belgian Congo, 3750 tons; Ontario, 375 tons; and French Morocco, 450 tons. These, with the expected quantities from Blackbird and Fredericktown, should bring supplies of cobalt by 1953 to about 6500 tons yearly, which is more than 2½ times 1949 consumption.

## Consumption of Cobalt

The principal uses of cobalt, the amounts, and trends are shown in an accompanying table. There are three general forms in which it is used: metallic, salts and oxides. The metal is used as an alloying agent with iron and other metals, particularly for magnet alloys, high-temperature alloys, and high-speed cutting tools. In the four postwar years, 1946-1949, this accounted for 65% of the total, but use of cobalt for magnetic and high-temperature alloys is rising steeply, as the accompanying chart shows, and in 1950 accounted for over 60% of the total. The proportion will be higher. The remainder is divided almost evenly between salts, mostly as driers for lacquers, varnishes, paints, inks, and the oxide forms, which generally are used as ground-coat frit to give better bond between steel and porcelain and for pigments. The appearance of defense needs, and the resulting use-restricting orders immediately disrupts this use pattern, however.

In the electrical industry the dominant use of cobalt is as the key constituent for permanent magnets. Ever since Honda of Japan in 1916 discovered the remarkable magnetic properties of steels containing high proportions of cobalt, the importance of this use has grown. There are now many different cobalt magnet alloys. The members of the Alnico family range in their cobalt content from 5 to 35% (aluminum, 12 to 6; nickel 28 to 14%; the remainder mostly iron). Some alloys, such as Vicalloy and the Permendur group, are one-half cobalt. The Westinghouse electromagnetic steel, Hiperco, is 35% cobalt. For magnets of great magnetic energy for their size—such as are needed in loudspeakers, television sets, and particularly for airborne communication and other electronic equipment—cobalt-steel alloys have no near competitor. Compared with tungsten-steel magnets, which were generally used prior to Honda's discovery, the magnetic energy per unit weight runs from 5 to 17 times greater. Cobalt appears to have no substitute for this purpose.

Cobalt imparts to alloys unusual ability to carry heavy loads at high temperatures. This puts them in great demand for superchargers, gas turbines, and jet engines that call for parts to be severely stressed for long periods at 1300 to 1500 F and for briefer times in the neighborhood of 1600 to 1700 F. For these alloys the percentage of cobalt varies from 13 to 66%. The Westinghouse alloys, Kovar, K-42-B, and Refractaloy, contain about 20% cobalt (remainder is various proportions of chromium, nickel, molybdenum and iron). The cobalt content of Stellites runs from 20 to 55%. Vitallium, about two-thirds cobalt, was developed originally as a dental and surgical alloy but is now used for its high-temperature properties as well.

Cutting tools that run at high speed, and consequently quite hot at the cutting area, are greatly improved by the addition of cobalt. These retain their cutting edge and hardness even at a dull red heat, which effects great savings in time and material in machining operations. They have been very important in our industrial economy. High-speed steels generally contain from 5 to 12% cobalt, this use in the postwar period accounting for about one-twentieth of the total usage.

Cemented carbides, in which cobalt forms the matrix or binder for the tungsten and other carbides, have an important place in high-speed machining of hard materials.

While these uses predominate in volume, cobalt has many other functions—some rather surprising. Until about 1935 the cause of serious malnutrition and deficiency diseases of cattle and sheep grazing in certain parts of Australia, New Zealand, Florida and Wisconsin remained a mystery. The answer proved to be a deficiency of cobalt in the grasses. Almost immediate and permanent recovery was effected by adding minute traces of cobalt salts to the animals' feed. The soils of those regions are now dosed with the salts with consequent elimination of these meat-animal maladies.

Cobalt is an important catalytic agent in many chemical processes. In particular, the presence of cobalt in the Fischer-Tropsch synthesis of liquid hydrocarbons speeds up the reaction by several thousand times. This use of cobalt, while important, requires but small amounts.

Unlike prices of some metals, that of cobalt has not fluctuated wildly. Since 1939, when the price stood at $1.24 per lb, it has risen at intervals and, as of last January, stood at $2.10.

The prospects for augmenting cobalt supplies with scrap are not good. The recovery of cobalt from salvaged materials is difficult. In general, cobalt used once is gone forever. This will be particularly true of its use in ceramics, paints and porcelain enamels.

Nickel and cobalt have become fundamental metals. Both are growing in versatility, for peacetime as well as defense uses. Fortunately, although supplies are temporarily short, users of these two metals do not have to embark on a long program of substitution.

**Annual Average Consumption of Nickel in the United States During 1946–1949, Inclusive**

| | Short Tons | Per Cent |
|---|---|---|
| Ferrous | | |
| Stainless steels | 15,374 | 19.0 |
| Other steels | 17,058 | 21.0 |
| Cast iron | 3,638 | 4.5 |
| Nonferrous | 25,072 | 31.1 |
| High-temperature and electrical resistance alloys | 5,538 | 6.9 |
| Electroplating anodes | 11,385 | 14.2 |
| Electroplating solutions | 570 | 0.7 |
| Catalysts | 451 | 0.6 |
| Ceramics | 180 | 0.2 |
| Others | 2,840 | 1.8 |
| Total | 82,106 | 100.0 |

# Flexible Sealers Find Wide Use in Industry

by **KENNETH ROSE**, Western Editor, Materials & Methods

***Many types of materials are available for sealing openings to prevent leakage of gas or liquid or to deaden vibration.***

● IN THE ASSEMBLY OF A unit there frequently arises the need to close openings or cracks in the structure to make them impervious to a gas or liquid or to deaden vibration. Materials for such uses, which require no structural strength, are usually called sealers. If structural strength is also required, soldering, brazing, welding or mechanical fastening over a gasket or packing can be chosen.

There are many types of sealers serving a wide variety of purposes in industry today. They can be divided into two broad classifications:

1. Rigid sealers—used to close openings in furnaces, pipes, dry cell batteries, chemical vessels, etc. These include certain refractory mortars, grouting, chemically resistant cements, sealing waxes, and the like. They are especially useful where vibration is not an important factor, for they possess no special damping ability. Rigid sealers are usually inorganic.

2. Flexible sealers—provide an economical means of closing gaps in a structure where vibration is a complicating factor. Vibration may be sound that must be deadened, or the lower-period shaking of the part being sealed or coated. For other cases flexibility is required to maintain a seal against thermal expansion, contraction, or other part movements. Flexible sealers are usually organic materials.

## Characteristics and Composition

A characteristic of all sealers—one that differentiates them from gaskets and packings—is that sealers bond themselves to the base materials, instead of being held mechanically by clamping. Costwise, this is an important advantage. Another feature of most sealers, in contrast in this instance to paints, is that they provide a certain amount of bulk, and can fill cracks or seal off openings lacking close fit-up.

Requirements for a flexible sealer, in addition to flexibility, bulk and bonding ability, are (1) resistance to attack by the substance being sealed against, and (2) resistance to deterioration at the working temperature, or through the range of working temperatures.

In most applications flexible sealers are used to seal against gases, liquids or solids. They are also used for surface protective purposes, and to maintain differential pressures. Because of the organic nature of these sealers they are not suitable for use at high temperatures. Formulation of the sealer itself determines the amount of resistance it will have against attack by chemicals, solvents, atmosphere and deterioration at elevated or low temperatures.

Sealers are composed of (1) a base material; (2) a vehicle; (3) filler; (4) pigment; and (5) modifying agents.

The base material is a rubber or an asphaltic material—natural or synthetic—or, an oil, usually vegetable in origin. The vehicle is gasoline, water, organic solvent of the ketone or ester type, or a drying or non-drying oil. The filler may be graded asbestos, cotton or other fibrous material, metallic filler such as powdered aluminum, or a mineral filler such as white lead or whiting. Pigments are of standard types. Modifying agents will usually be materials used in other types of sealer, which are added to modify physical or chemical properties.

This blending of materials makes it possible to obtain a very wide range of properties in sealers, but also makes difficult the classification of most commercial formulations. There are also a few sealers based upon synthetic resins, and using organic solvents as vehicles without filler or pigment.

Certain types that are required to have a minimum of shrinkage are made without a vehicle. Often the material sets up by action of a catalyst, accelerator or vulcanizing agent.

## Base Materials

*Rubber*—In general, rubber-base sealers and coatings have excellent water resistance, good flexibility, good adhesion to impervious surfaces, and wide color possibilities. Natural rubber types have poor resistance to oil and petroleum fuels, and are not suitable for applications where these must

be sealed against. The butadiene-styrene synthetic rubbers, or Buna-S type, and the butyl rubbers are not oil resistant, but otherwise are suitable for most purposes for which natural rubber would be chosen. Frequently a reclaimed rubber is used, though the butyl-type rubber has superior ozone resistance. Acrylonitrile or Buna-N synthetics are resistant to both petroleum and aromatic oils, and chloroprene rubbers (Neoprene) are resistant to petroleum fuels, but less resistant to aromatic fuels. Thiokol, on the other hand, is a material having the best resistance to aromatic fuels.

Because of their good resistance to aromatic fuels (nitrile synthetic types) and to temperature extremes within a wide range, the rubber-base types are used considerably in the aircraft industry. They also are finding some automotive uses, and are considered quality sealers in marine and building applications.

While not true synthetic rubbers, the silicone elastomers are best grouped with these materials. Several materials are used, with slightly differing properties, but all have poor resistance to petroleum products, to carbon tetrachloride, benzene, acetone, amyl acetate, ether, butanol, xylene, toluene, and many other organic solvents, aliphatic and aromatic. They are highly water-repellant.

*Asphaltic*—This term is used broadly to include natural asphalts, bituminous tars and pitches, oil tars of various softening points, and mineral waxes. Sealers using these materials as a base have good outdoor durability and low cost as their principal advantages. They soften at only slightly elevated temperatures, and are readily soluble in petroleum and other organic solvents. Black is the only color in which they are available.

Asphaltic sealers find uses in automotive applications where sealing is done against air only, and as a protective and sound-deadener in the same industry. This sealer type is also used in most structural applications. Other important applications include marine uses as a protective coating and sealer; for coating and sealing outdoor storage tanks; and, for coating and sealing chemical tanks.

*Vegetable Oil*—Linseed and soybean oil are principally used, with an occasional addition of other oils to promote or retard drying. Linseed oil and white lead are used primarily in the making of putty and calking compounds, which are the principal members of the group. Advantages for these two compounds include their relatively low cost, ease of handling, and the wide range of color possibilities available. Though certain types of calking compounds set up with little flexibility after complete oxidation of the drying oils, they can be specially formulated to retain a measure of flexibility.

Oil-base sealers are primarily building materials. The ease with which they can be cleaned from wood or metal surfaces without discoloring the surface, and their wide range of color possibilities, combined with low cost, have given them first call in this field.

*Synthetic Resin*—Several types of synthetic sealers are made up as clear "dopes" consisting of a thermoplastic resin and a solvent. Their biggest advantage is their nearly complete transparency when used as a thin film. Synthetic resin types are used for sealing automotive and aircraft glazing, for instrument dials, etc.

***A coating of underbody sealer being applied to this Nash automobile provides corrosion resistance, sound deadening and protection against dust and fumes.***

*Special Types*—Special uses have brought about the development of special types of sealers, which may be applied either by extrusion from a gun, by knife, brush, roller, or by spraying. Only specially thin sealers can be sprayed, as most sealers are made in a consistency too heavy to permit spraying.

In the making of certain types of aluminum tanks, it is desirable to apply a sealer to the overlapping surfaces at the seams, so that enough sealer is deposited in the seam at the time the tank is made up. Afterwards, the lapped seams must be welded for strength. A special sealer has been produced that can be applied to the overlapping surface, permitting spot-welding through the sealer. This is accomplished by making up a formulation containing a high content of aluminum in a vulcanized oil base. The aluminum provides a conductive path for the welding current, and fuses to assist in forming a metallic bond between the overlapping aluminum pieces. The oil base resists the quick heat of welding without burning or spattering.

***Modified asphalt compound being applied to interior seams of Kelvinator home freezer shell.***

***This silicone paste, manufactured by the Chemical Dept., General Electric Co., makes a waterproof seal for aircraft ignition systems.***

## Sealer Applications

*Aircraft*—Two large-scale applications for sealers in aircraft have helped to make modern air transport successful. One is the sealing of the entire cabin space to produce the pressurized cabin, while the other is the use of the interior of the plane's wings as gasoline or oil storage space.

To make the wing leakproof against aviation gasoline, a special sealer has been formulated with a synthetic base that is cured by catalytic action rather than hardening by evaporation of a vehicle. The catalyst is added to the sealer—a heavy liquid—just before it is applied to the wing's interior areas. It may be brushed, knifed or pressure extruded along all seams, over all rivets, and over any voids or holes, converting the wing into a liquid-tight tank. The sealer retains its flexibility and adhesion at –100 F, and is usable to about 180 F. It is, of course, resistant to the solvent action of the fuel. However, it is also necessary to apply an overcoat of another synthetic rubber material to prevent the aromatic elements in the fuel from dissolving the bond to the metal.

The same sealer is also used to seal over the metal seams in making cabin structures pressure-tight. For this purpose it is usually used in heavier viscosities. Because of the sealer's rather low specific gravity it adds little to the weight of the plane, while at the same time it possesses a tensile strength greater than 500 psi in the cured condition.

A synthetic rubber putty is also being used by the aircraft industry for sealing voids, while other standard sealers are being used for sealing glazing and instrument glasses.

Aircraft ignition systems, and particularly the terminals, are sealed over with a silicone compound, either a paste applied as a thick coating or

a thin film of liquid, to prevent corona discharge at high altitudes. The silicone material distinguished by its slow plasticity, and called bouncing putty, is sometimes used to seal closed systems.

In addition to their use on original aircraft construction, sealers are important maintenance materials as well. The synthetic rubber sealer used for wing tank and cabin sealing is frequently used in a formulation providing faster cure when leaky wing tanks must be repaired quickly in order to return the plane to service.

*Automobile*—In the automobile industry today more than 30 lb of sealers, heavy coatings and adhesives are used per car. As fenders, body and door shapes become even more complicated, sealers will undoubtedly be used in ever increasing quantities to exclude air, water, fumes, dust and noise.

Steel underbody surfaces are given a coating of protective compound, usually asphaltic in nature, to protect against water, dirt, stones, vibration, and to reduce rusting. The underside of the car dome is similarly treated to deaden sound and reduce heat transmission. An aluminum-filled sealer is also used as a body solder and smoother.

In addition, many of the body seams are sealed over to make the body interior more comfortable, and yet they will not bleed through the paint overcoat. Some of these body sealers are formulated so that they will swell and cure when the body goes through the paint-drying oven.

A clear sealer based upon a synthetic resin is used to seal automotive glass into rubber channels. Windshields, headlights, and side glazing may make use of another sealer, made from a reclaimed rubber base, which remains permanently flexible.

Manufacturing conditions play an important part in determining the type of sealer used for most automotive applications. A widely used autobody sealer is made up with only 80% solids and the remainder vehicle, rather than the higher solids content found in the heavy pastes. This more mushy material can be applied quickly by means of a calking gun.

In addition to their passenger car uses, sealers are also important in the making of trucks, trailers, refrigerated vehicles, etc. For example, during the production of aluminum truck bodies at one firm, the builders discovered that when the aluminum came in contact with steel in the presence of water it would set up a destructive galvanic action. To overcome this trouble they found that a sealer would isolate the steel when applied where steel screws or steel moldings contacted the aluminum skin.

The same problem arose during the manufacture of aluminum trailers at another firm. A special problem in the case of the trailers was the tendency of the sheets to gap between the fasteners, thus necessitating a shift to costly pre-stressed sheets to overcome this tendency. Today, however, the firm uses a sealer to solve the problem in a less costly manner.

Makers of refrigerator trucks make use of sealers to close all body seams where warm air might enter. As these trucks frequently carry food products, exclusion of dust and fumes is also important. Trailers made of plywood or pressed board also use sealers to close body seams against dust and fumes. Both oil-base and synthetic rubber types are available for these uses.

Another need for sealers and coatings is in the automotive reconditioning shops. Renovation of old cars —where loosening of body metal is apt to lead to leaks and noises— can now be economically done with thick sealers that are used as body calking. Underbody coatings will also help to deaden vibration, and stop corrosion, while sealers around glazing will help to make the car body leak-proof in bad weather.

In general, the most widely used sealers and coatings for automotive work are of the asphaltic type, which are usually modified with a small quantity of rubber to provide resistance to vibration. In critical areas sealers of the rubber-base type are used exclusively.

*Refrigerating and Air Conditioning*—Manufacturers of refrigerating and deep-freeze units, and air conditioning equipment use large quantities of sealers to shut off leaks of cooled air from the systems. They also use coatings to prevent corrosion of metal that is subject to frequent or constant wetting. Most of these are of a modified asphaltic type.

Refrigeration, however, poses several special problems for sealers. No odor can be tolerated because of the danger of food contamination. Thus, sealers that do not utilize an organic solvent are preferred. The sealers must retain adequate flexibility and adhesion at service temperatures, which may be as low as -40 F. Other sealers require a base of reclaimed rubber, in which the solvent is completely evaporated before the unit is put into service, for sealing refrigeration units. Another type makes use of extruded solid tape or beads, applied like a gasket to seams or openings. This material retains some residual tack because of incomplete cure; curing is completed after installation, thus avoiding the use of a solvent.

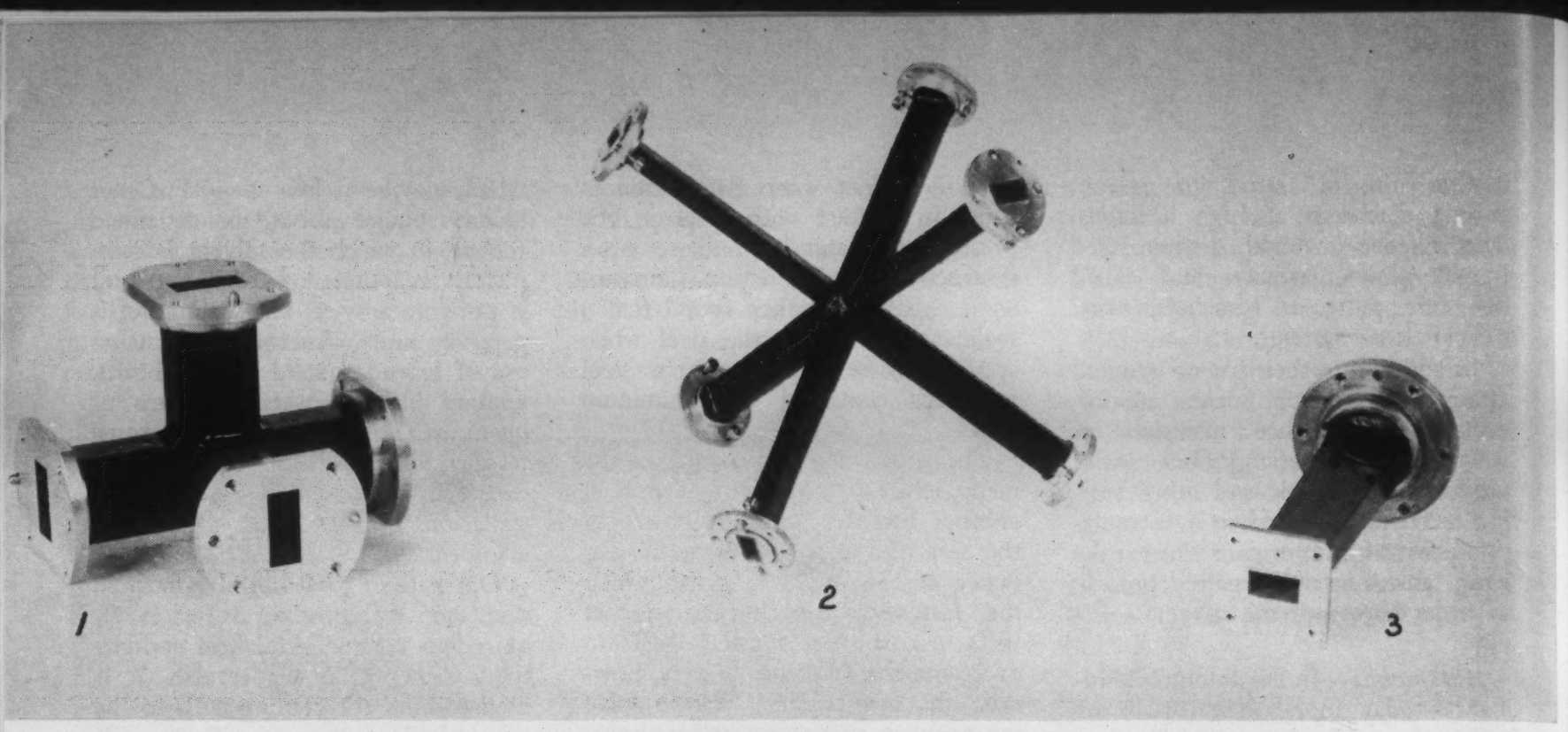
Opposite to what has already been said, one refrigeration sealer is required to possess good heat conductivity rather than the reverse. It is used to bind the cooling coils to the inner shell of the unit. These coils themselves would make only a slight contact with the flat surface of the shell, so the sealer is applied around them to increase the conductive cross section. Here a heat-conductive filler is added to the sealer to obtain good heat removal.

Air conditioning units use sealers on ducts that carry the cooled and humidified air both to prevent contamination of the air by warm air or dust, and to maintain the very slight differential pressure in the system. Oil-base calking compounds are widely used.

*Chemical and Other Storage Tanks* —Welded or bolted tanks for crude oil are sealed with a synthetic sealer resistant to petroleum products. Where the tanks holding the crudes are subject to corrosion by the acid waters that collect under the oil level, an asphaltic coating below this level has given good service at low cost. Synthetic resin sealers have been used to seal brick acid tanks.

*Marine*—Protective coatings in bilges make use of bituminous coatings, which are low in cost and quite effective against salt water. Seams in wooden decks are usually calked with an asphaltic material, though on naval vessels the calking may be done with a rubber-base compound. Oil-base calking compounds may be used as sealers for marine glazing and in the superstructure, where the asphaltic materials would bleed through light-colored paints.

On pleasure craft and some commercial vessels, deck sealing and bedding for glazing is being done with the newer rubber-base materials. These materials do not dry out as do the putties and other oil-base sealers. On naval aircraft carriers the synthetic rubber deck calking has the advantage of being unaffected by aircraft fuels.




*Electroformed waveguide components for microwave systems are circular or rectangular tubes with highly critical tolerances on the inside dimensions. Similar parts are also made by precision casting, when the production runs and tolerance requirements permit.*

# Microwave Components:

# Precision Casting vs Electroforming

***The commercial balance struck between precision casting and electroforming methods in making waveguide components can be a valuable guide to the efficient manufacture of other products.***

by **A. A. FELDMANN**, National Bureau of Standards

● THE INCREASING IMPORTANCE of microwaves for radar, navigational aid systems (Loran and Shoran), relay systems and radio-telephone communication networks requires increased production of the microwave components that go into transmitting and receiving equipment and test instruments. A large percentage of these microwave components are the special precision tubes known as waveguides. These waveguides may be straight sections, bends, twisted shapes, tapered sections, transition pieces from round to rectangular cross-sections, and multi-armed junctions.

In spite of the restricted range of their use, these waveguides are an interesting example of a balance between several different methods of manufacture. Various kinds of precision casting and electroforming are used, depending on the exact shape of the waveguide, the tolerances that must be held, and the number of pieces that are on order. The same evaluation of costs, tolerances and production runs may be involved in designing and making other precision products.

All waveguides require a smooth, reflecting finish on the interior surface, with inside dimensional tolerances varying from $\pm 0.005$ to $\pm 0.0005$ in., depending on the size of the piece and its application. The size of a waveguide section depends on the microwave frequency for which it is to be used; inside dimensions of standard waveguides vary, on rectangular cross-sections, from 2.840 by 1.340 in. down to 0.122 by 0.061 in. The pieces can be made of brass, copper, silver, nickel or aluminum, and highly conductive or anti-corrosive coatings are sometimes added over the base metal.

Most waveguide components are made by skilled workers in a series of machining and soldering opera-

tions that require precision machinery, expensive jigs and fixtures. The accuracy demanded on the inside surfaces makes soldering and brazing difficult and gives a high percentage of rejects. These fabricating difficulties have kept the price of waveguide components high. With some of the more complicated instruments, the costs are almost prohibitive.

As the demand for waveguide components has increased, new methods have been developed to increase production and cut the amount of skilled labor necessary, maintaining the required accuracy at the same time. Some of these manufacturing techniques are still in the experimental stage, while others are already being used successfully in commercial production.

## Casting

Ordinary sand casting cannot give the dimensional accuracy necessary in waveguides, but several other casting methods have been used successfully.

*Die casting* can give the dimensional accuracy and surface finish required for most microwave components, without subsequent machining. The steel dies are expensive, though, and die casting is economical only on long production runs. Another disadvantage is that the process is best suited for low-melting point alloys.

*Investment casting* appears to be practical. The method used is an adaptation of the lost wax process used by dentists and jewelers to cast delicate inlays and small articles with intricate details. Dimensional accuracies of $\pm 0.002$ in.[1] are possible on dimensions under 5 or 6 in., and the size of microwave components requiring such accuracy is usually within these limits. Any metal can be cast, and the fine surface finish obtained eliminates the need for machining in most cases.

*Mercasting,* a process licensed by the Mercast Corp., has been used with some success. Mercury is poured into a die and frozen at -60 F. The solid mercury pattern is then dipped in a refractory mix, which forms a coating around it. When the refractory coating has dried and hardened, the mercury is melted at room temperature and allowed to run out. The mold is then fired at a high temperature in a kiln and the molten metal is poured in by centrifugal or gravity methods. Dimensional accuracies of $\pm 0.003$ in.[2] have been reported by users.

These casting processes partially answer the mass production problem. Entire assemblies that were formerly made in a dozen or more parts can be cast in one piece. No soldering is required with a one-piece casting.

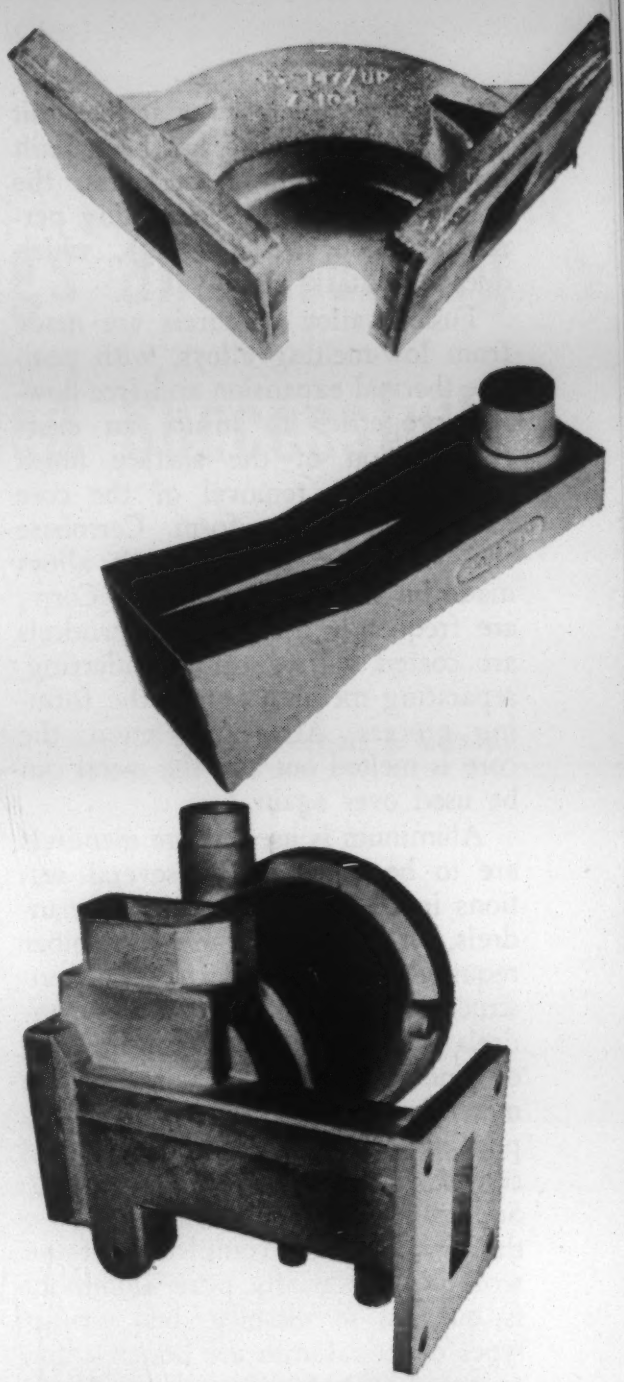
Magnesium-aluminum alloys[3] are especially amenable to casting. Lightweight components cast from these alloys and covered with a highly conductive silver coating are desirable for aircraft installations. For precision measuring instruments, however, accuracies of $\pm 0.002$ in., the best obtainable by any casting process, are not good enough.

## Electroforming

Electroforming is becoming the accepted method of making many waveguide components, especially those requiring close tolerances. Large amounts of metal are electroplated over a core, or mandrel, and the shape and dimensional accuracy of the mandrel determines the quality of the finished part. Dimensions of special components have been held to $\pm 0.00005$ in. over 10-in. lengths.

Most metals used for electroplating can be used for electroforming, and the surface finish exceeds the best results of other processes. The close dimensional accuracies obtained are stable, since the metal electrodeposited on the mandrel is, in the case of silver and copper, essentially free of stress. Electroforming might also be the only possible way of making some waveguides with intricate inside surfaces.

Good electrical conductivity is required in all waveguide components, and the best conductors, silver and copper, are used for almost all electroformed components. To overcome the low strength of pure silver or copper, laminated construction is often used in those waveguides. The first layer of silver is thick enough to provide a conducting skin for the frequencies at which the component is to be used. The next layer can be copper, nickel or aluminum. Nickel gives the guide sufficient mechanical strength and rigidity and keeps the outside from tarnishing. A rhodium or palladium flash on the inside surfaces will prevent atmospheric influences and maintain good conductivity. The use of aluminum is of recent date, since it had been considered impossible until recently to electroplate aluminum successfully.[4] Although the process has not yet been applied commercially, it is of great potential importance in aircraft installations and military field instruments, where reduction of weight is always an advantage.



***Investment cast waveguide components are widely used. Die casting is usually cheaper on large scale production, while electroforming holds closer tolerances than die casting and is cheaper on very small scale production. (Arwood Precision Casting Corp.)***

For small production runs, electroforming is the most economical manufacturing process for any shape. Very little equipment, a few d.c. power outlets, tanks and filters are necessary. Occasional inspection during electroforming is adequate and few skilled men are needed.

*Expendable Mandrels*—The shape, required number and dimensional tolerances of an electroformed part determine the type of mandrel used. The mandrels can be made of a variety of materials and can be permanent or expendable.

Plastic mandrels, usually made of polystyrene or Lucite, are molded in metal dies, and a thin metallic coat, usually silver, is evaporated or sprayed over the entire surface to provide conductivity. Mandrels can

be produced in this way at low unit cost. After the form has been built up to the required thickness, the mandrel is removed in boiling perchloroethylene ($CCl_2$:$CCl_2$), which does not attack the metal.

Fusible alloy mandrels are made from low-melting alloys, with positive thermal expansion and free-flowing properties to insure an exact reproduction of the surface finish and complete removal of the core material from the form. Cerrobase and Cerrotrue, two bismuth alloys made by the Cerro de Pasco Corp., are frequently used. These mandrels are coated with a thin, conducting, separating medium before the forming process. After completion, the core is melted out and the metal can be used over again.

Aluminum is used where mandrels are to be made up of several sections in the so-called multiple mandrels, or where the small number required does not justify the construction of a mold. Aluminum mandrels are covered with a thin layer of zinc to facilitate adhesion of the metal during electroforming. The deposition of metal is made onto the surface with no separating medium. Sodium-hydroxide is used to dissolve the mandrel after completion of the work. Commercially pure aluminum is quickest to dissolve, but various types of Duralumin are better suited as mandrel material, and an aluminum alloy with a low copper content, like 61S, is desirable. The hardness and machinability of Duralumin give very good surface finish and dimensional accuracies to several ten thousandths of an inch.

*Permanent Mandrels* — Permanent mandrels work on the principle of poor adherence of the electroformed metal to the surface of the mandrel. The materials used are stainless steel, glass and Invar. All these materials are hard and difficult to machine, and brittleness may also be a problem. The best surface finishes possible with grinding and lapping can be obtained, however, and mandrels have been made to an accuracy of $\pm$0.00005 in. The amount of work which is necessary to construct such a mandrel is considerable, but the cost can be written off on a number of units rather than on just one, as is done with expendable mandrels.

Permanent mandrels are used for straight sections of waveguide, step-up or step-down adapters, and funnel-shaped rectangular "horns," as some microwave antennas are called. Their use is mainly confined to the construction of high-precision components of test equipment and laboratory apparatus, where extreme accuracy, rather than cost, is of prime importance.

Stainless steel mandrels are plated on directly or used with a thin, conductive metal separating coat. The completed form is heated and the mandrel pushed out after electroforming. The difference in the coefficients of expansion between copper or silver on one hand and stainless steel on the other, aids in removing the mandrel. Considerable force is sometimes necessary, however, and the inside surfaces of the waveguides are easily damaged. If a separating medium is used, it is melted out after completion of the part, before the mandrel is withdrawn. Tin is often used as such a separating film, but care must be taken to avoid oxidation of the tin, which would prevent the withdrawal of the mandrel from the work.

Glass mandrels are coated in the same way as plastic ones. A silver coating is evaporated or sprayed onto the surface of the mandrel. After electroforming, advantage is taken of the low expansion of glass in relation to silver and copper, and the mandrel is pushed out after the form has been heated to about 600 F. Glass is a good mandrel material since it can be lapped optically to exceptionally high dimensional accuracy.

Invar, an iron-nickel alloy, is the metal with the lowest coefficient of expansion, 0.5 x $10^{-6}$, as compared to copper 9.3 x $10^{-6}$, silver 10.6 x $10^{-6}$ and nickel 7.4 x $10^{-6}$. It is one of the toughest materials to machine, however. The electroforming is done directly on the surface of the mandrel, without a separating medium. Separation of mandrel from work is simple. The form is placed in boiling water for 25-30 min and the mandrel is slipped out easily.

## Applications

Almost all of these methods are used commercially; each has its own specific applications. For very large production, especially of lightweight components, die casting appears to be the best process. Where the quantity desired does not warrant the high cost of tooling for die casting and where high melting alloys are used, investment casting or *Mercasting* is called for. These conditions would apply for a large percentage of microwave components. Dimensional accuracies obtainable with any form of casting can be held to $\pm$0.003 in. or even $\pm$0.002 in. for some parts, when the components are correctly designed for casting. Cast surface finish is good and no additional machining is required in most cases.

Electroforming permits the highest dimensional accuracies and the best finish on inside surfaces. Outside surfaces of electroformed parts are not as smooth as those of cast components and have to be machined in some cases, although the machining can usually be confined to the ends where connecting flanges are mounted.

For large production of parts that can be cast, electroforming cannot compete for economy with any of the casting methods. For very small production, on the other hand, it is the most economical process. Where geometrically intricate inside surfaces are involved and where highest dimensional accuracies (up to $\pm$0.00005 in.) are demanded, electroforming has no competition.

## References

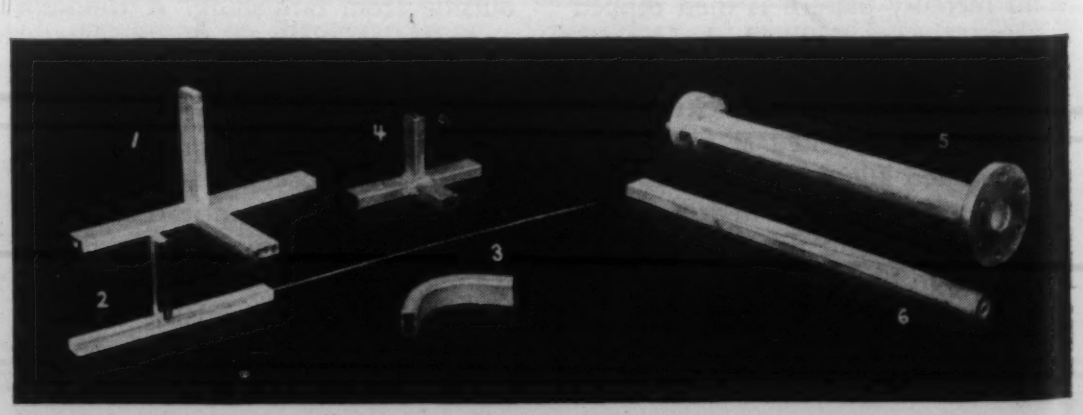

[1] Precision Metalsmiths, Inc., Cleveland, Ohio, *Metal Progress*, Oct. 1949.

[2] *Iron Age*, Mar. 1949; *Metal Progress*, Oct. 1949; *American Foundryman*, Sept. 1949.

[3] Arwood Precision Casting Corp., Vacuum Casting Corp. MATERIALS & METHODS, Sept. 1950.

[4] Summary Report No. 6538, to Bur. Air Nav. by Battelle Memorial Institute, May 12, 1950, on "Investigation of Electroforming Methods of Manufacture of Waveguides."


***(1) Dural mandrel on which part 4 is electroformed; (2) plastic mandrel for a T-shaped component; (3) electroformed bend; (5) transition piece from round to rectangular cross section (end flanges are soldered on); (6) plastic mandrel used to electroform part 5.***



# Steel Castings and Welding Can Be Combined Successfully

***Recent designs use parts fabricated by welding together several steel castings or a combination of cast and wrought pieces.***

by **PHILIP O'KEEFE**, Assistant Editor, Materials & Methods

● TRADITION PUTS STEEL casting and welding in opposing camps. There has been a feeling among many engineers that a piece should be either a casting or a weldment; that there is an extensive middle ground is a relatively uncultivated idea. The voluminous literature turned out by both sides, showing how cast pieces could be better fabricated by welding or how weldments were profitably changed to castings, has fostered this misconception.

However, in the last few years designers have begun to explore the possibilities of combining the best points of both techniques, and some impressive advances have been made in the adaption of cast-weld pieces. Also, both the steel foundries and welding shops themselves have begun to recognize the desirability and economy of welding several steel castings together for complicated pieces that are impractical or expensive to fabricate in a single casting or weld entirely from rolled plates and shapes. In some cases, it has been found that castings and wrought pieces can even be profitably welded together.

It is interesting to note that the turrets of Russian T-34 tanks, cast in one piece in the early models, are now made by welding a plate of rolled steel on top of a cast ring which forms the sides. Experience has evidently shown the desirability of cast-weld construction.

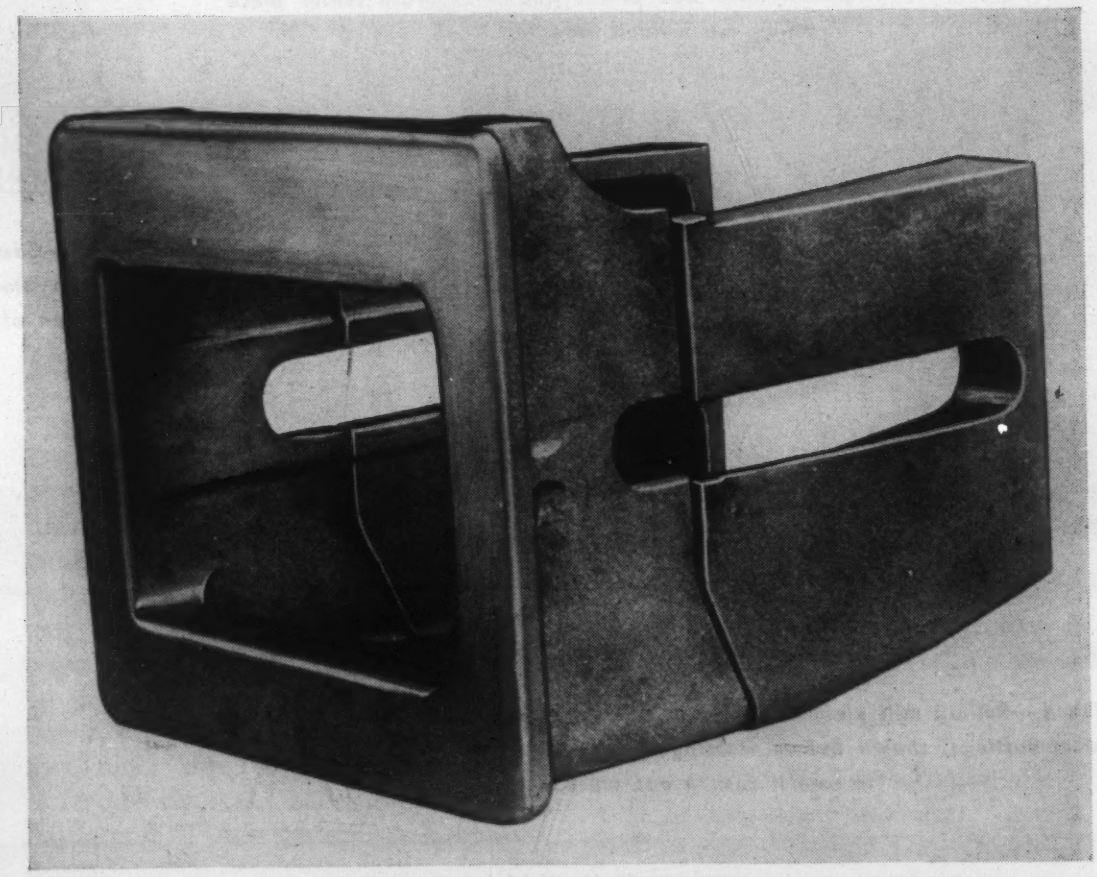


*Fig 1—Setup of three separate steel castings before they are welded together to make a railroad car striker.*

## Design Principles

Pieces that cannot be economically or efficiently integrally cast are usually characterized by large or numerous cores. The castings would be relatively light for their size and of intricate design. Core boxes increase pattern costs and make chilling expensive. The setting of cores is difficult and dimensional control becomes uncertain, while risering problems increase and cracks in the cored areas are more difficult to repair.

A weldment using wrought plates and shapes exclusively may be impractical or expensive if the piece requires weight for damping or stabilization or if its fabrication would require welding together a large number of small pieces.

In redesigning a casting or a weldment to cast-weld construction, the following basic rules should be adopted:

1. The designer of the original part should be consulted to ensure proper application to the actual function of the piece. The stresses induced under load will govern cast-

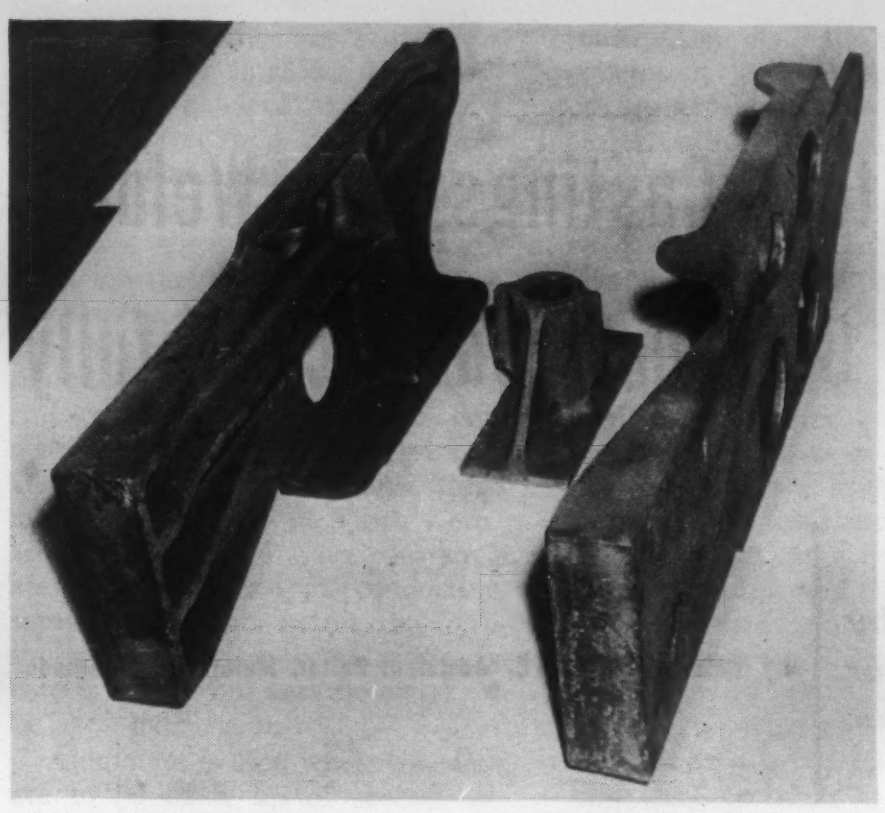


*Fig 2—Cast-weld redesign for the center filler to go with the striker shown in Fig 1. Two cast steel side pieces and a separate center piece casting are welded together.*

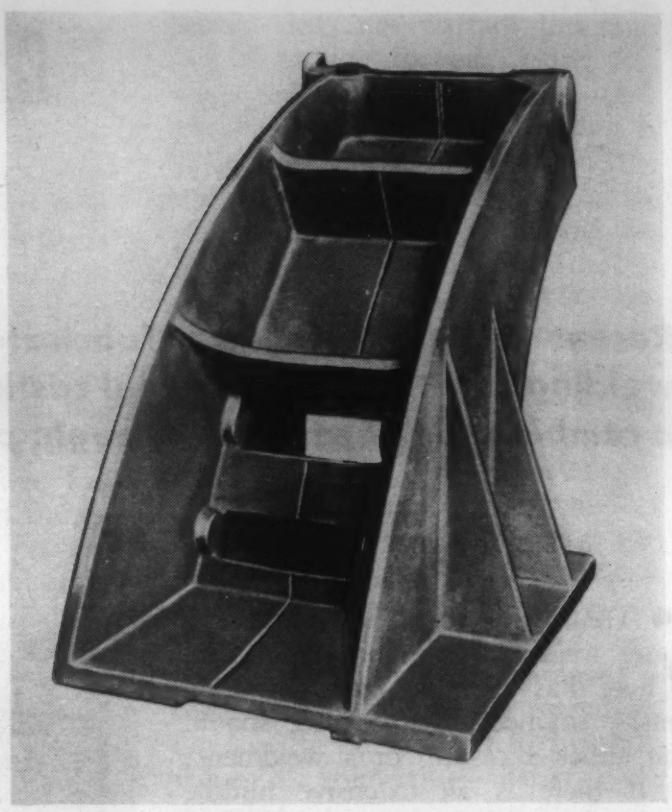


*Fig 3—Cast-weld strip repeater unit after weld-union of two steel castings. By elimination of cores and reduction of pattern requirements, overall manufacturing costs were lowered materially.*

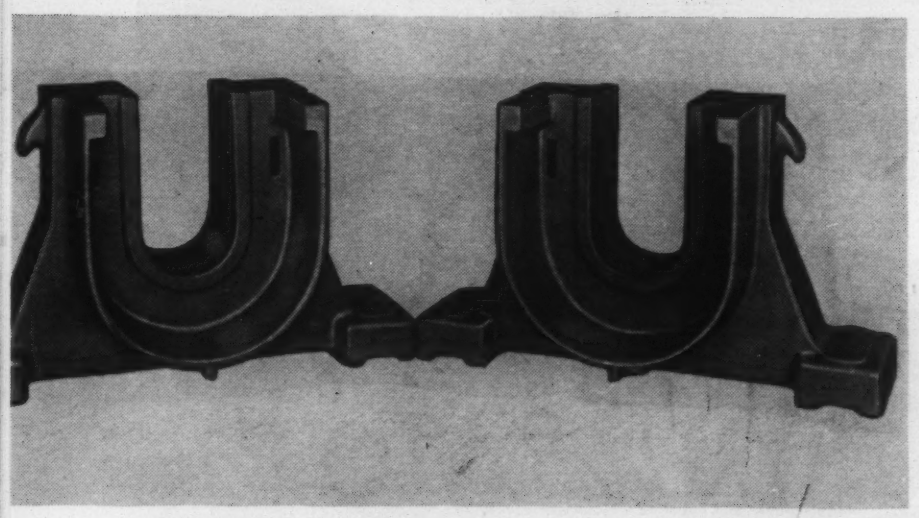
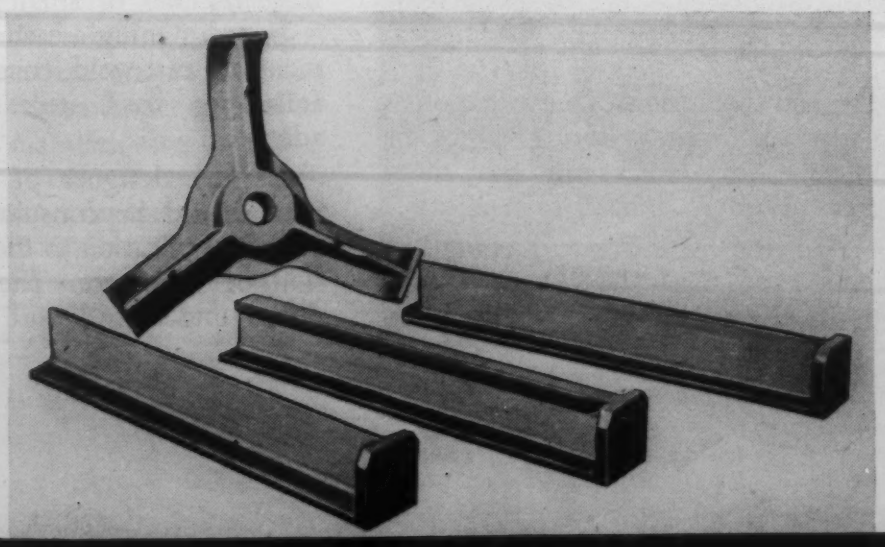


*Fig 4—Rolling mill pinion housing to be made from two separate steel castings, shown before welding. This part would be difficult to core if cast in one piece.*

*Fig 5—Four-piece cast steel assembly for 600-lb tripod casting, used on coilers for rolling mill machinery, shown before joining of separate units in cast-weld operation.*



weld design just as they control integral casting or weldment design. People unacquainted with the function of the piece can make serious errors in re-design.

2. Lower costs, reduction in defects, better damping qualities and improved delivery are the important advantages to be investigated.

3. The piece should be broken up to leave as few cores as possible in the component castings.

4. Welding should be held to a minimum by proper location of joining lines.

5. The number of run-out tabs and backup plates should be minimized.

6. The welded assembly must be stress relieved.

## Welding Specifications

Steel castings can be welded with the same facility as wrought steel of the same chemical compositions. With carbon contents below 0.25%, conventional welding techniques can be used and the procedures are the same

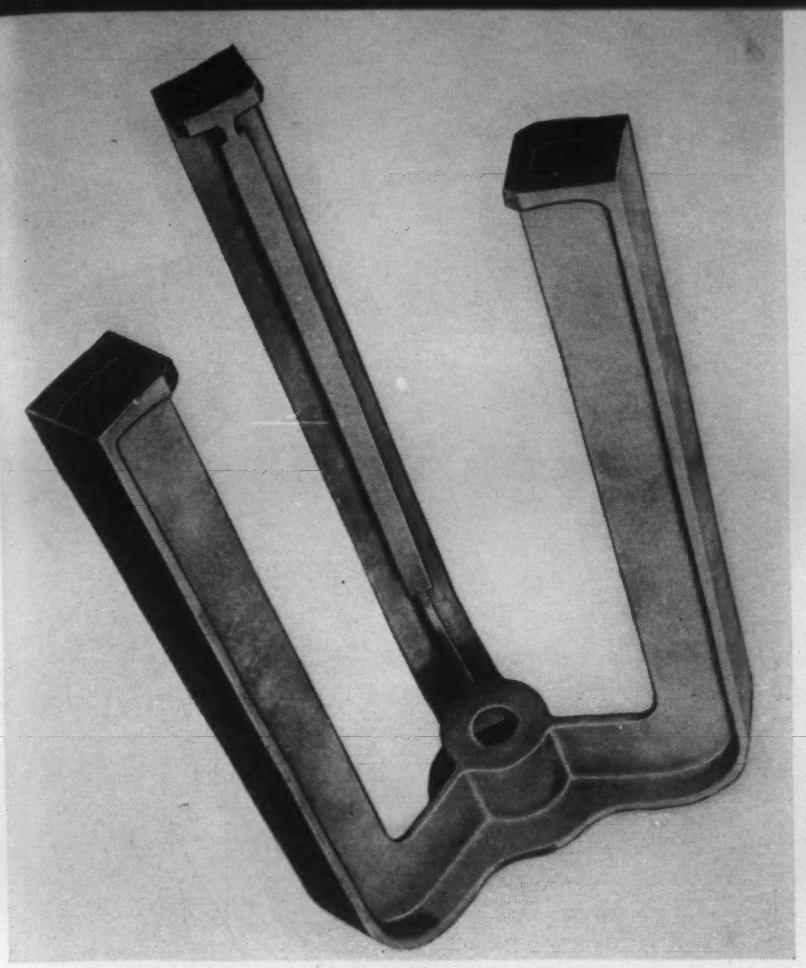
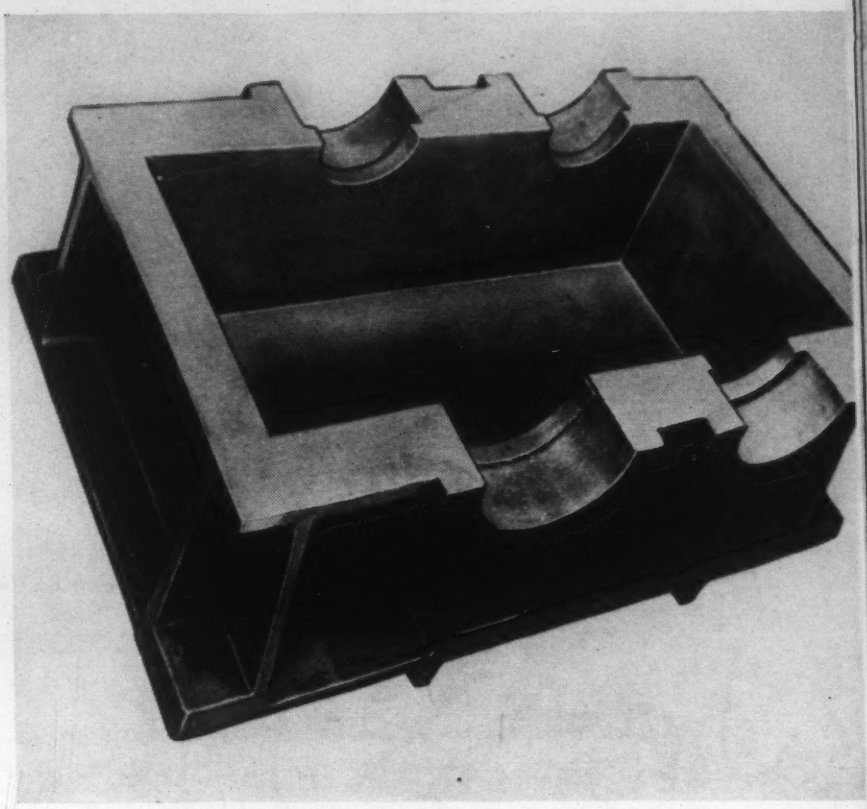


*Fig 6—Completed cast-weld tripod design after welding together of the four pieces shown in Fig 5. This design supplanted an intricate one-piece casting.*

*Fig 7—This 5,000-lb drive housing was formerly made with steel castings used only for the bearings. Redesigned for cast-weld construction, the housing has two cast sides, with bottom and end pieces of rolled plate, welded together to form the massive unit.*



as for wrought steel. With carbon contents above 0.25% and with special alloy compositions, certain precautions are often necessary and special procedures are employed, as with similar wrought steels.

Tentative ASTM specifications have been proposed for carbon steel castings suitable for fusion welding. These allow the carbon content to be as high as 0.35% with a maximum manganese content of 0.60%, providing the casting is heat treated after welding. Castings which are not heat treated are limited to 0.25% carbon with 0.75% max manganese. The specifications also provide that for each 0.01% reduction in carbon content an increase of 0.04% manganese above the specified maximum is permitted up to a limit of about 1.00% manganese.

The same materials are recognized as readily weldable by procedures accepted by the ASME Boiler Code Committee and the American Welding Society.

The structures and properties of fusion weld metal depend upon a number of factors, including carbon content, the cooling rate, gas content and slag content. The prime requisite of a weld is ductility, and an effort should be made to keep carbon content of the deposited metal low, since the cooling of the weld is frequently rapid enough to induce hardening if the carbon content is high.

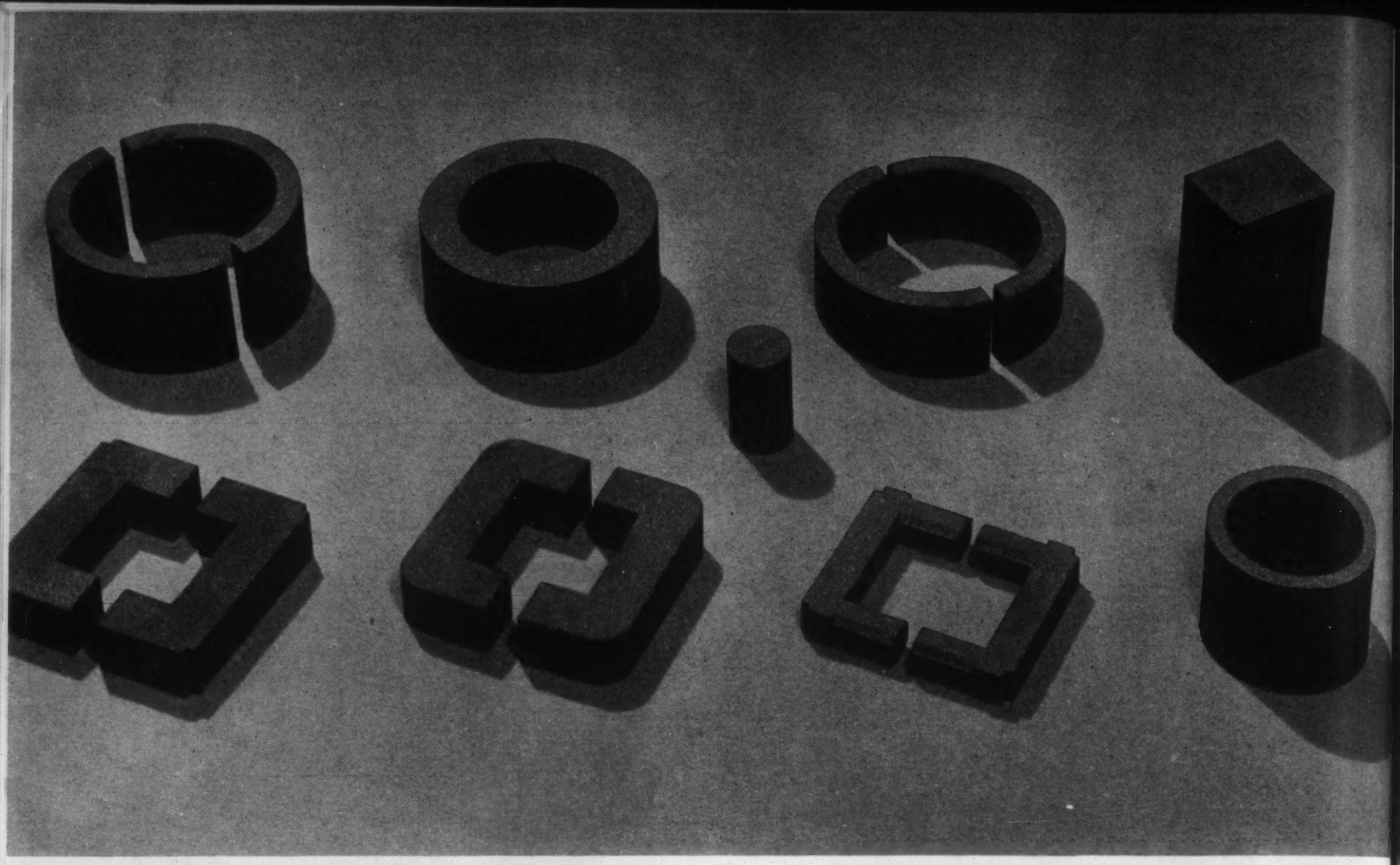
The chemical composition of the base metal is specified because fusion welding induces a temperature gradient in the base metal which induces all sorts of structural conditions. If the carbon content of the base metal is high enough to make it air hardening, the heat affected zone near the weld may become brittle. Certain alloying elements other than carbon may bring about air hardening of the base metal and the alloy content must be limited, unless special precautions are taken, such as preheating the casting to 300 to 600 F.

Increased hardness in the heat affected zone can be removed by annealing the welded casting for a definite time at 1200 to 1250 F. Internal stresses resulting from the welding operation can also be relieved by this annealing.

## Welding Practice

A high grade heavy-coated electrode is considered essential for arc welding steel castings. These coatings contain little or no combustible material. Multi-layer welding, high currents and peening should be employed for low and medium carbon steel castings. Preheating is sometimes necessary, depending on the design of the piece.

Welds in steel castings can be radiographed by gamma-ray or x-ray methods to ascertain the soundness of the welded section. The chief defects that may occur are incomplete fusion, slag inclusions and porosity. The mechanical properties in casting-to-casting and casting-to-wrought pieces are of the same order as in similar welds between two wrought steel pieces.



*Ferrite core materials can be used in magnetic amplifiers, carrier frequency power transformers, filter and loading coils, and small machines and measuring instruments. (Ferroxcube Corp. of America)*

# Ferrite Materials Permit Improved Designs of Magnetic Devices

by **EBERHARD BOTH**, Signal Corps Engineering Laboratories

***Ferrite magnetic materials fill a gap between the two conventional materials at frequencies in the audio to RF range, giving smaller eddy current losses than laminated materials and higher permeability than powder cores.***

● WITHIN THE PAST two decades, research and development work on magnetic materials has provided the electrical and electronics engineer with a wide variety of new and improved materials of both the permanent and magnetically soft type. Advances in both the theoretical understanding of ferromagnetism and in production techniques are reflected in the spectacular magnetic properties of today's commercial products like Alnico V, Supermalloy, grain-oriented silicon-steel, and grain-oriented nickel-iron.

While the major development effort was devoted to metallic materials, the possibilities of magnetic materials consisting of metal oxides were being studied by scientists in Japan and Europe. A permanent magnet material, now known as Vectolite, was the first to emerge from this work in 1933, but magnetically soft materials did not appear on the market until 1946, when commercial production of ferrite type bodies was started in Holland.

Similar materials became available from American sources in 1948, and their production was expanded at a rate unprecedented with any other

magnetic materials, due to the rapidly growing demand by the television industry. Impending reductions in the output of TV receivers will make a large part of the present production of ferrite bodies available for other purposes.

A typical ferrite compound is the ferrosoferric oxide or magnetite, $FeO \cdot Fe_2O_3$, formed by the divalent and trivalent iron oxides. The divalent oxide FeO can be replaced by the oxides of other divalent metals like nickel, manganese, copper, zinc and cadmium.

Two ionic arrangements, the *normal* and *inverted*, are found. Only zinc and cadmium ferrite are known in the normal arrangement; neither of these is ferromagnetic. The inverted structure is common to all other ferrites.

The important thing about these two different types of ferrite structures is that both arrangements remain unchanged in solid solutions of normal and inverted ferrites. It is in these solid solutions that the most desirable properties of high permeability and saturation can be achieved.

## Permeability

Magnetic materials are capable of increasing the flux created by a given electromagnetic field to a high multiple of the air flux. The multiplying factor, which can range from little more than one up to values of $10^6$, is called the permeability. Although magnetic core materials achieve a given inductance value in a coil with a smaller number of turns, the resistance of the coil is not reduced in the same proportion, since the core itself introduces losses which can be equal to or larger than the gain due to the increased flux. High permeability and low losses are the general requirements for all core materials in alternating fields, and achieving optimum performance involves determining the proper balance between permeability, core losses and copper losses.

A sharp permeability peak is apparent as the percentages of normal and inverted ferrites are varied in solid solutions. A certain percentage composition gives a maximum value, while the permeability drops off to a much lower value for the pure inverted type and reaches zero for the pure normal ferrite. Fig 1 illustrates this for nickel-zinc ferrites.

The Curie temperature is the point at which the permeability drops off sharply with further heating. The permeability of ferrite compounds increases as the Curie temperature decreases toward room temperature. The higher the permeability of a compound, the lower its Curie temperature. The variation of permeability with temperature is shown in Fig 2 for several nickel-zinc ferrites.

Low Curie temperature presents a serious disadvantage in practical applications, limiting the operating temperature of the coil. As illustrated in Fig 2, the permeability of usable ferrites varies widely with temperature changes, impairing the stability of the inductance value. This is important where the core forms a closed magnetic path and the true permeability of the material is utilized. If the magnetic path contains an air gap of 1% or more of the total length, however, the temperature variation is drastically reduced, along with the effective permeability.

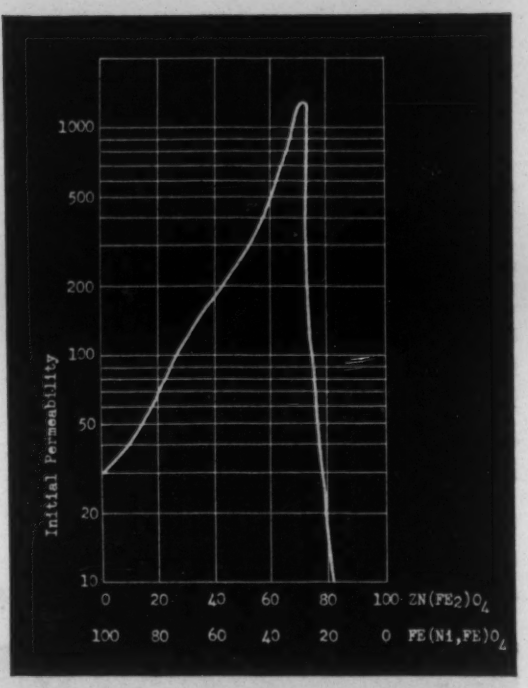
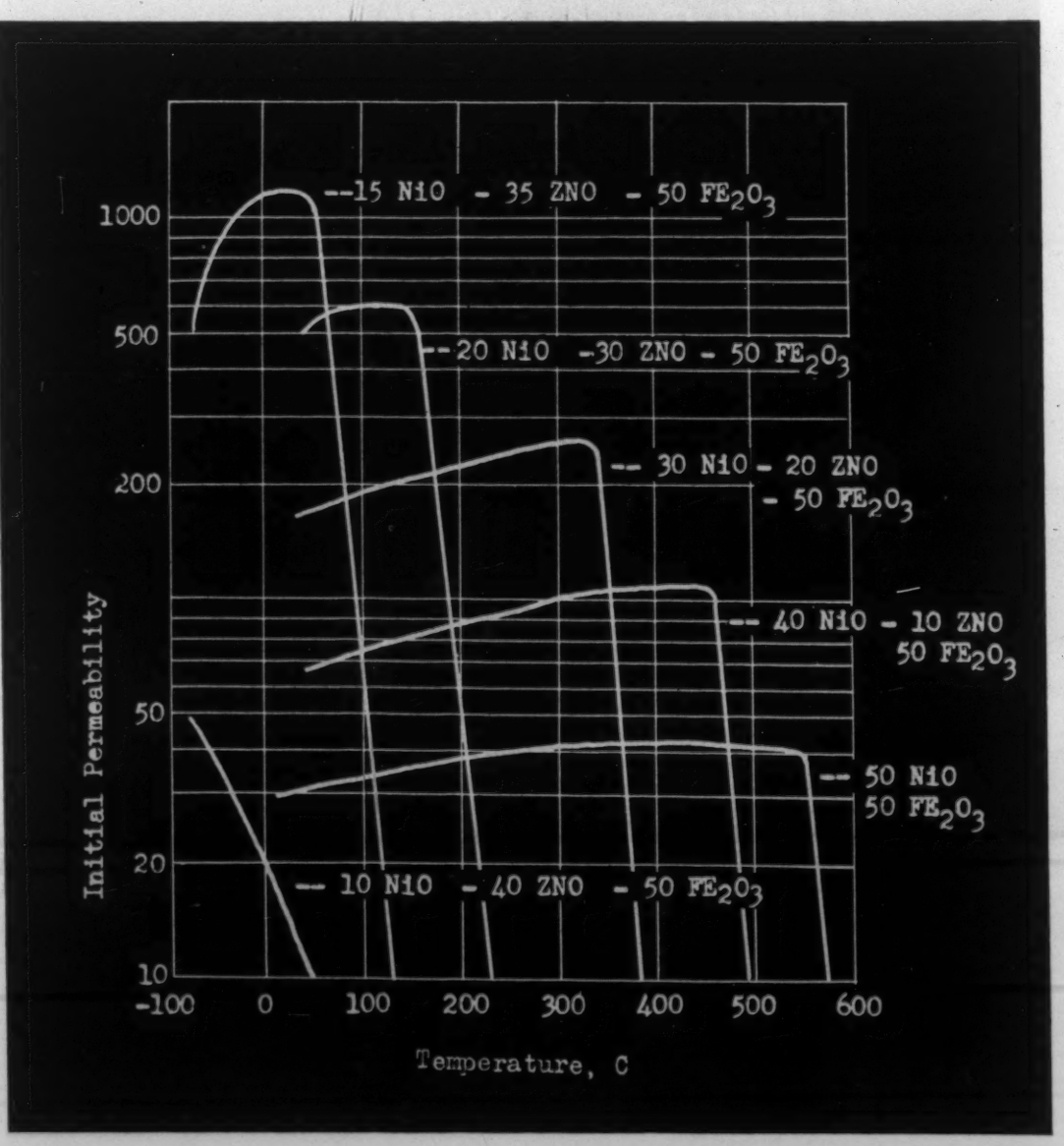



*Fig 1—The permeability of nickel and zince ferrite solid solutions is maximized at an optimum percentage composition. (From Harvey, Hegyi and Leverenz, "RCA Review")*

## Magnetic Processes

Ferromagnetism does not occur in an isolated atom, but only when certain atoms are assembled in well defined arrays, such as symmetrical crystal lattices. These atoms will then form *domains*, or tiny elements in which the paramagnetic moments of all the atoms are aligned in parallel.

*Fig 2—Permeability increases as the Curie temperature decreases toward room temperature. (From Harvey, Hegyi and Leverenz, "RCA Review")*



The alignment is subject to disturbance by the thermal agitation of the atoms at any temperature above the absolute zero; the point at which it breaks down is the Curie temperature.

The magnetization process and its effect on the domains is illustrated in Fig 3, with typical BH curves. In the demagnetized state, the domains, though fully magnetized themselves, have been distributed in a random manner by a demagnetizing process, leaving the material as a whole without a magnetic moment. On the BH curve this state is represented by the zero values of both the field strength H, and the induction or flux density B.

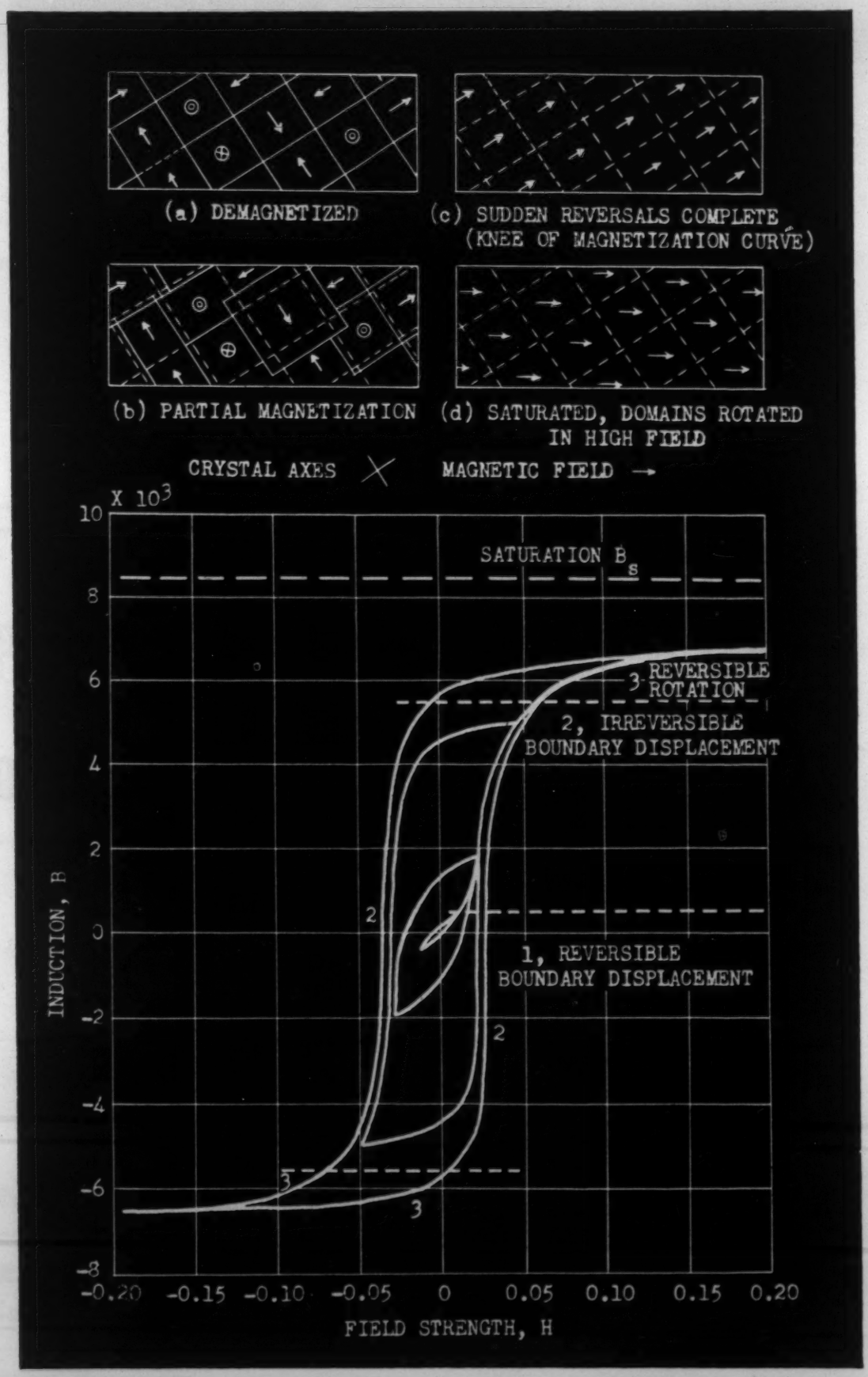
When a small field is applied the domains undergo a change in size. Those having a component in the field direction grow at the expense of their less favorably oriented neighbors. Upon removal of the field, the domain boundaries will return to their former location. This process is called a reversible boundary displacement. The ratio of the induction B to the field H is the initial permeability of the material.

With a slight increase in field strength, B increases very rapidly and no longer returns to zero when the field is turned off. The domains which are unfavorably oriented to the field are taken over completely by their growing neighbors and the newly created giant domains have no tendency to return to the original arrangement when the field is removed. This is irreversible boundary displacement.

When the field is increased sufficiently above this value, the giant domains will align themselves parallel to it by rotation, and the material will be fully magnetized or saturated. In some materials this alignment is not compatible with the crystal orientation, and the crystal energy realigns the domain magnetization to the nearest cube edge as soon as the field ceases. This means that the magnetization process due to domain rotation is reversible.

In the practical utilization of magnetic materials, the operating conditions can be conveniently classified according to the three processes just described. Operation in the initial magnetization range prevails in input transformers, filters, variable inductances, antenna loops, and other communication components. Operating at the knee of the BH curve are mainly power transformers, relays, motors and generators. Pulse transformers, magnetic amplifiers, and saturable reactors in general utilize the material in the saturation range. Ferrite type materials can be used for all three of these operating conditions; their greatest merits, however, seem to lie with applications involving low and medium flux density values, since their absolute saturation value is rather low.

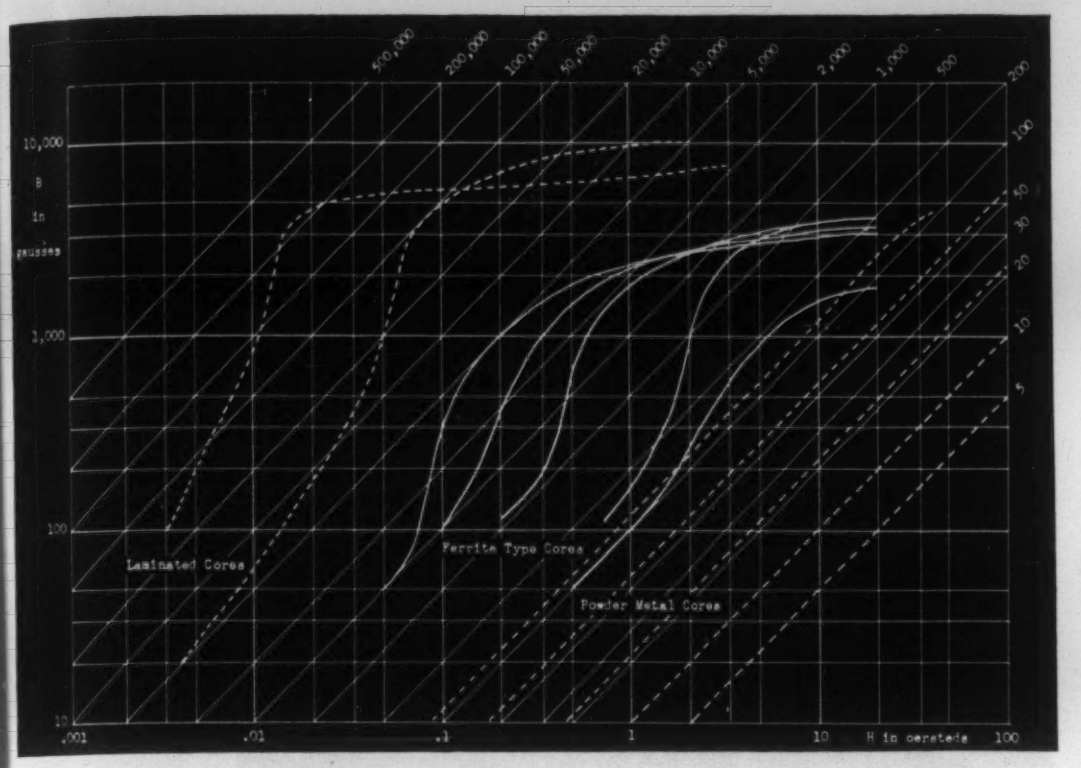
***Fig 3—The effect of magnetization on the tiny domains in a ferromagnetic material at each section of the hysteresis loop. (From R. M. Bozorth, "Reviews of Modern Physics")***




## Losses

The hysteresis loss may be of only secondary importance when the material is used in a range where the permeability is truly reversible. In applications operating at the knee of the BH curve, and even more in those utilizing the saturation range, the hysteresis losses will be of major importance.

As the operating frequency is increased, the eddy current loss becomes predominant. Eddy currents arise when the core provides a conducting path for the electromotive force (emf) which accompanies the changes in the core's magnetization




***Ferrite material closes the gap between laminated and powder metal materials. The solid lines indicate the ferrite type materials.***

state. They can be reduced by laminating the magnetic material, by subdividing it into individually insulated particles, or by increasing its volume resistance. The conventional metallic materials whose resistivity cannot be varied by more than a factor of about 10 can be used at high frequencies only in the form of powder cores. In ferrites, however, the resistivity is about $10^8$ to $10^{12}$ higher than in metals, and eddy currents are practically nonexistent. They can be used even in heavy cross-sections, at frequencies up to the megacycle range. Unfortunately, however, these materials are dielectrics and possess rather large dielectric losses at higher frequencies. The displacement currents due to dielectric losses are as objectionable as eddy currents and appear to present a serious limitation in the use of ferrites.

For practical purposes the losses of an inductance coil can be expressed in several ways, all of which are derived from the loss angle, tan $\theta = R/wL$; more commonly known is the reciprocal of this value, the quality Q of a coil. If only the losses due to the magnetic core are considered, tan $\theta$ becomes equal to $\mu''/\mu'$, the ratio of the imaginary to the real part of the permeability. Finally, a "loss factor" $1/\mu'Q$ or $\tan \theta/\mu'$ is used as an overall figure of merit for the magnetic material.

The loss factors for ferrites increase roughly in proportion to the frequency. For each material, the loss factor increases sharply at a well defined frequency; however, permeability drops to the level of conventional powder iron cores somewhere between 100 and 1,000 megacycles. Losses in the neighborhood of one megacycle increase due to dielectric displacement currents.

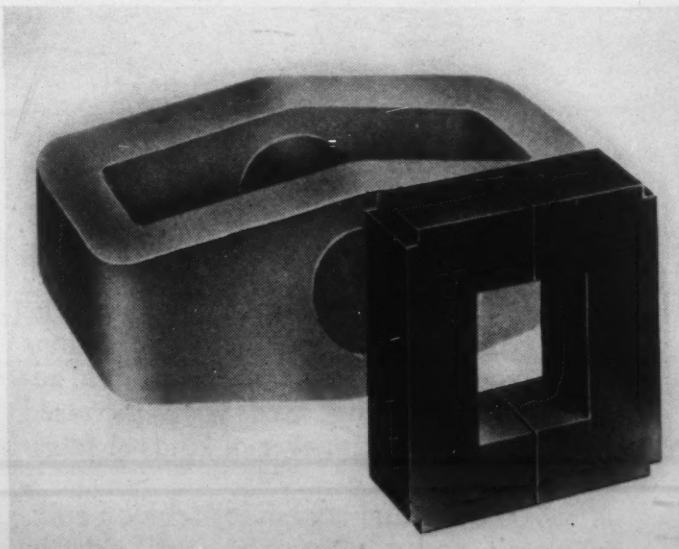
## Applications

From past experience, especially in television sweep transformers, it seems likely that ferrite materials can successfully compete in applications where the operating flux density is at the knee of the BH curve. They close the wide gap between laminated and powder metal core materials. Initial permeabilities cover the whole range between the values of 125 for Permalloy powder cores and several thousand for laminated nickel-iron. The saturation of ferrites is rather low, but maximum permeability is much higher than with any powder materials.

For flux densities of 3,000 gausses, ferrite materials require a much smaller magnetizing current than powder cores. This is particularly important in magnetic amplifier applications.

In comparing the advantages and disadvantages of ferrite bodies, consideration must be given to incidental properties, such as thermal expansion, shock and vibration resistance, moisture absorption, aging characteristics and machinability. Data on these properties are still far from being complete. It is evident, however, that ferrite bodies, besides having attractive magnetic properties, give the designer much more freedom in choosing the optimum shape for magnetic cores than laminations do. Ferrite transformer cores, for instance, can be designed to completely enclose the coil winding in a very compact, well shielded and easily mountable component, while laminated cores require more space and extra weight in shields and mounting brackets. In ferrite cores the legs which carry the windings can be cylindrical so that less wire is required per turn than with the square coil forms used with laminations. The air-gaps in ferrite core structures can be kept small by grinding the mating surfaces to a finish of almost optical quality; other dimensional tolerances, however, do not compare with the accuracy of punched, drawn or machined metallic parts.

Ferrite cores will give optimum performance only if their particular properties are recognized and integrated in the design of the component for which they are to be used. Replacing laminated or powder cores by a piece of ferrite of equal size and shape will often give discouraging results. Expert design, on the other hand, has in numerous applications resulted in spectacular reductions of size, weight and space required, and/or in improved performance of the component involved. Possible applications include carrier frequency power transformers, pulse transformers and harmonic generators, magnetic amplifiers, filter and loading coils, magneto-strictive oscillators, concentrators for high frequency heating, and small machines and measuring instruments.



***When ferrites are used to replace conventional materials, the core should be redesigned to fit the electrical and mechanical properties of the new material, as shown in front. (Stackpole Carbon Co.)***

***An objective observer surveys the problems and possibilities of structural adhesives to aid industry in evaluating these materials.***

*Most adhesives now under test need elevated temperatures and pressures for curing. These requirements are being lowered by research, however. (U. S. Plywood Corp.)*

# Structural Adhesives—

## Their advantages
## Their limitations
## Their future

by **LT. WILLIAM E. DIRKES,** Materials Laboratory, Wright-Patterson Air Force Base

● THE EFFECTIVENESS OF recently developed structural adhesives can be judged from the fact that no failures have been reported in aircraft applications of these adhesives, when they have been used as required by the Air Force. The number of applications and the amount of structural adhesives being used have increased rapidly in a number of kinds of fabrication.

Structural adhesives are not a cure-all, and many problems still exist in obtaining the maximum strengths from these materials, but there are many fabrication and design problems which good structural adhesives can solve. As more people become familiar with the techniques and possibilities of these adhesives, and as better adhesives become available, the number and types of applications should multiply even more rapidly. The proper adhesive chosen for a suitable application can produce excellent results. Adhesives, though limited in their capabilities, can produce structural strengths and configurations which are often impractical with other structural materials.

## Advantages

The two main selling points of structural adhesives are: (1) smoother surfaces can be obtained in fabricated parts and structures by using adhesives instead of rivets and other fasteners; and (2) considerable weight can be saved in many applications. Both of these points are extremely important in airplane design, and a good part of the development work on adhesives has been done by aircraft people.

Structural adhesives have been used in many airplanes for bonding stiffener panels to thin sheet exterior surfaces. Originally, stiffener panels were riveted to the exterior panels, and it was hoped that the exterior surfaces could be made of thinner sheet, thereby reducing the overall weight of the aircraft. However, it was found that as the surface sheets were made thinner, fatigue failures occurred at the rivet

holes. The proper use of structural adhesives eliminated these fatigue failures.

Probably the most important use of structural adhesives in aircraft is in the fabrication of aluminum honeycomb sandwich materials. Rigid, low density materials made from metal honeycomb cores bonded to metal faces have strength properties much greater than most structural sandwich materials. The construction of these metal sandwich materials has been made possible primarily by the development of high strength adhesives.

The use of adhesives may also be dictated by space limitations. They are also used to protect joints against fluid leakage and prevent bi-metallic corrosion. Thermal insulation and the reduction of hysteresis losses are provided in some applications.

An important feature of adhesives is their versatility. Not only are adhesives suitable for bonding metals, but compounds are available for joining rubber, leather, wood, cloth, plastics and glass as well. These materials can be joined to each other or in combinations.

## Available Types

High strength adhesives are available in the form of solids, powders, liquids and tapes. Most of the adhesives in use today are one- or two-part liquid systems which can be manufactured in viscosities suitable for use with spray or paste applicators. Each adhesive system has advantages and disadvantages, both in strengths available and in ease of use in production.

Tapes, which are films of uncured adhesive, eliminate the problem of controlling the bond thickness and are readily adaptable to production use. Tapes are produced as both supported and unsupported films. The supported films are generally cloth-like materials coated with uncured adhesives, while unsupported films contain only the uncured adhesives. The tape adhesives in general seem to be better than the other forms for easy and rapid assembly. Only a few tapes are available, however, and these present specific problems. For example, the only tape presently approved for Air Force use requires a primer coat which is sprayed on the metal parts to be bonded, so that the fabricator is not freed from the problems inherent in liquid systems.

Most liquid adhesives require careful control of the solvent evaporation from the adhesive. The controls necessary are specified by the manufacturer, generally consisting of designated lengths of time for air drying or force drying prior to bonding. The solids and powders generally require a larger proportion of handwork by skilled workers than is required by liquids and tapes.

## Some Problems

Each adhesive presents its own problems, but the major problems encountered are similar for most adhesive systems. Probably the most universal problem is that of cleaning the surfaces to be bonded. The effects of unclean surfaces are not too noticeable in the use of low strength adhesives for nonstructural applications, but with structural adhesives, a noticeable decrease in bond strength occurs when surfaces are not cleaned properly.

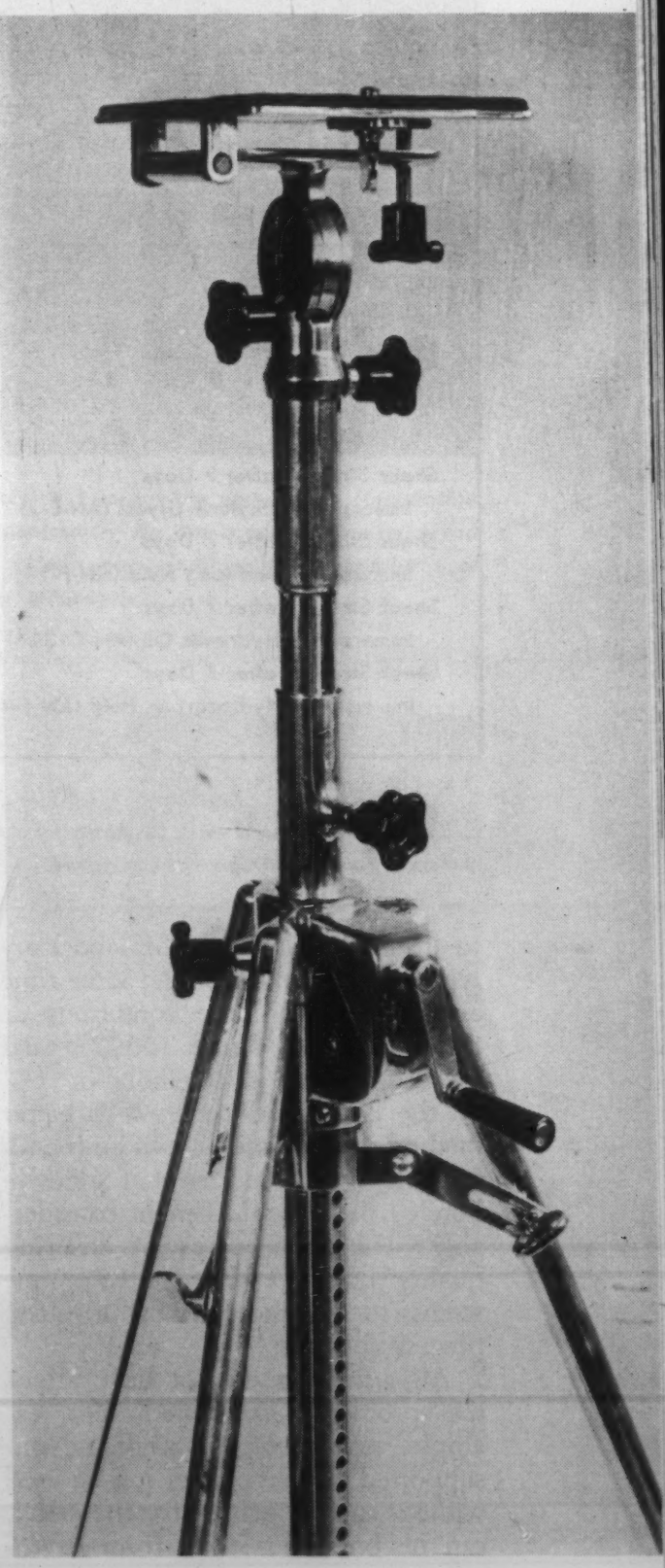
For laboratory testing, a widely accepted cleaning method for clad aluminum alloy is immersion in a warm solution of sulfuric and chromic acids. This type of acid bath produces consistently clean surfaces with excellent bond strength for a variety of adhesive systems. Production cleaning methods for any particular adhesive may consist of a mild acid bath, dilute alkaline bath, vapor degreasing or electrolytic cleaning, as recommended by the adhesive manufacturer. The types of cleaning which are suitable will vary with the adhesive used and the materials to be bonded. Subsequent to cleaning, a control problem arises, for the cleaned surfaces must not be contaminated by handling or excessive exposure to air.

Another problem encountered in the use of adhesives is the temperature control necessary for curing bonds properly. The adhesives which are approved by the Air Force require temperatures in excess of 300 F for curing, and most adhesives in use at the present time have rather narrow limits on temperature-time cycles for optimum results.

The pressures necessary to form high strength bonds present additional problems. Air Force approved adhesives require pressures of 500 psi or greater for optimum results. Although dead loading of parts to be bonded might give good results in some cases, it is not suitable for extensive use in production. The installation of heavy pressure fixtures is only practical if a large amount of adhesive bonding is to be done. Small hydraulic presses are normally used in laboratories both for maintaining the proper pressures and for heating bond samples, and this method can be used for the fabrication of many small items.

Another serious problem is that of inspection of bonded assemblies. The only means of determining the strength of cured bonds accurately is to test the bonds destructively. Since this is not practical for production assemblies, the Air Force has adopted a system of inspection procedures. Present Air Force inspections consist of tests of the adhesive

***This camera tripod shows how joints between unlike metals can be rigidly bonded without welding and with no finishing operations. (Ciba Co., Inc.)***



**Air Force Specifications for Minimum Mechanical Properties of Bonded Joints**

| Type Test | Condition | Minimum Strength, Psi |
|---|---|---|
| DRY STRENGTH TESTS | | |
| Standard Temperature | | |
| Shear Strength | 72 to 76 F | 2500 |
| Elevated Temperature | | |
| Shear Strength | 178 to 182 F | 1250 |
| Low Temperature | | |
| Shear Strength | −65 to −70 F | 2500 |
| Standard Temperature | | |
| Fatigue Strength | 72 to 76 F | 650 |
| Low Temperature | | |
| Fatigue Strength | −65 to −70 F | 650 |
| Standard Temperature | | |
| Long Time Strength | 72 to 76 F | 1600 |
| Elevated Temperature | | |
| Long Time Strength | 178 to 182 F | 800 |
| Standard Temperature | | |
| Bend Test | 72 to 76 F | 150 (lb) |
| Standard Temperature | | |
| Impact Strength | 72 to 76 F | 10 (ft-lb) |
| Low Temperature | | |
| Impact Strength | −65 to −70 F | 5 (ft-lb) |
| FLUID EXPOSURE TESTS | | |
| Shear Strength after | Specification | |
| 30 Days Salt Spray Exposure | QQ-M-151 | 2000* |
| Shear Strength after | | |
| 30 Days Immersion in Tap Water | 72 to 76 F | 2000* |
| Shear Strength after 7 Days | | |
| Immersion in Ethylene Glycol (AN-E-2) | 72 to 76 F | 2000* |
| Shear Strength after 7 Days | | |
| Immersion in Anti-Icing Fluid (AN-F-13) | 72 to 76 F | 2000* |
| Shear Strength after 7 Days | | |
| Immersion in Hydraulic Oil (AN-O-366) | 72 to 76 F | 2000* |
| Shear Strength after 7 Days | | |
| Immersion in Hydrocarbon Fluid (AN-F-42; Type II) | 72 to 76 F | 2000* |

* Average Strength, Psi

*These figures represent the requirements for a structural adhesive acceptable to the Air Force. Many adhesives have considerably better properties.*

to insure quality, tests of laboratory type panels bonded at the same time and under the same conditions as the production parts, 100% visual inspection, and disassembly of 1% of the completed parts. If a better method of inspection could be found, both fabricators and users of adhesive bonded parts would benefit considerably. The best means of insuring quality bonds at the present time seems to be the use of adequate process controls.

All adhesives do not have all of the problems mentioned. For example, several of the available unsupported adhesive tapes can be used without surface primer for the metal, can be bonded with a force of 25 psi, are easy to apply, and can be assembled within a much shorter time than the adhesives which require pre-drying or precuring before bonding.

## Epoxide Resins

The use of epoxide resins as adhesive bases eliminate some of the fabricating problems. These formulations develop tensile shear strengths greater than 4000 psi. Bonds can be made with the contact pressure of the parts to be bonded, and the cure can be completed at room temperature. However, being relatively new, the epoxides have not yet been developed to the extent that all problems have been eliminated. There are still difficulties in elevated temperature strength, brittleness, the short pot life, and the difficulty of application in production.

Epoxide resins are made from several formulations, some with various filler materials added for specific strength properties. The unfilled resins have good room temperature properties, but are weak in both elevated and low temperature strengths. The filled resins are better in elevated and low temperature strength. Unfilled resins can give good strength with simple contact pressure, but with the filled resins care must be exercised to see that all trapped air is worked out of the bond area.

Generally, these resins are very viscous fluids or pastes. The resins harden by the addition of small amounts of activator. When the activator is added, the consistency of the resin does not change appreciably until the pot life of the adhesive ends and the resin sets in the form of a hard plastic type material. The pot life, or usable life, may vary from 20 min to 6 hr, but maximum strength is not generally reached for at least four days at room temperature. If a pot life of several hours is required, it may take more than 24 hr to develop handling strength.

The epoxide resins screened to date cannot be sprayed or brushed due to their viscosity. Application methods seem to be restricted to using spatulas or doctor blades. Epoxides must be mixed in small batches, for the addition of an activator raises the temperature, which will cause a large batch to heat sufficiently to shorten the pot life materially.

The above problems present some difficulty for large production uses of epoxide resins, but they are being used commercially in a number of applications, with excellent results. The advances made by the development of this type of adhesive cannot be over emphasized. Epoxide resin adhesives can be used for many small items without large expenditures for curing ovens and heavy pressure fixtures. They make it possible for the designer to specify structural adhesives for applications which might not be considered, if large expenditures for curing equipment were necessary.

## Future Developments

To date, room temperature, ele-

vated temperature and low temperature tensile shear tests have been made with some phenolic resin-synthetic rubber base tapes, as well as bend and fatigue tests. These tests are so varied and the adhesives have shown so many good mechanical properties that there is reason to expect that some of the tapes might pass the remaining U. S. Air Force requirements. These tapes consistently produce good quality bonds, and they seem to be highly adaptable to production use. Although plans for future development tend toward lower curing temperatures and pressures, this type of adhesive seems to be one of the better possibilities for industrial use in the near future.

Current development work by the Air Force has been channeled into two types of adhesives which are designed to suit the needs of the Air Force. One of the adhesives has a high tensile shear strength at room temperature and maintains a relatively high strength (1000 psi) at 400 F. The second program is for the development of an adhesive capable of 2000 psi in tensile shear after a curing time of 24 hr at room temperature under low pressure (approximately 5 psi). Additional requirements have also been imposed on this adhesive, such as 180 F elevated temperature strength and storage stability. The results of these contracts have shown that both adhesives can be developed and each has been produced experimentally.

Additional development work is still to be done on these adhesives. The elevated temperature resistant adhesive has a poor shelf life and must be stored at 40 F or less. The room temperature setting adhesive is being developed to maintain 50% of its strength at 180 F, and the target strengths have been met by several experimental adhesive systems, but formulation costs, ease of use and the length of the pot life must be improved. Although epoxide resins have been screened as room temperature setting adhesives, the adhesive being developed for the Air Force is not an epoxide and it differs in that the target strength at room temperature is to be reached within 24 hr after applications, while the epoxide resins, at present, require four to eight times as long to cure at room temperature.

The results of the two development programs outlined above show that there is a good possibility for the development of a truly general purpose adhesive. One of the main Air Force requirements for such an adhesive is that it be capable of use for field repair of Air Force equipment. An ideal adhesive for field repair work would be the type of adhesive that industrial concerns could use with ease. It would be convenient if such an adhesive had a storage life of several years under adverse conditions of temperature and humidity, would be capable of use at room temperature under contact pressure, and would require only a solvent wash on the parts to be bonded. The pot life of such a general purpose adhesive should be several hours, yet a high strength bond would have to be formed within 24 hr.

Although the adhesive system outlined above might seem to be far in the future, research work is about to be initiated with objectives very similar to those described above.

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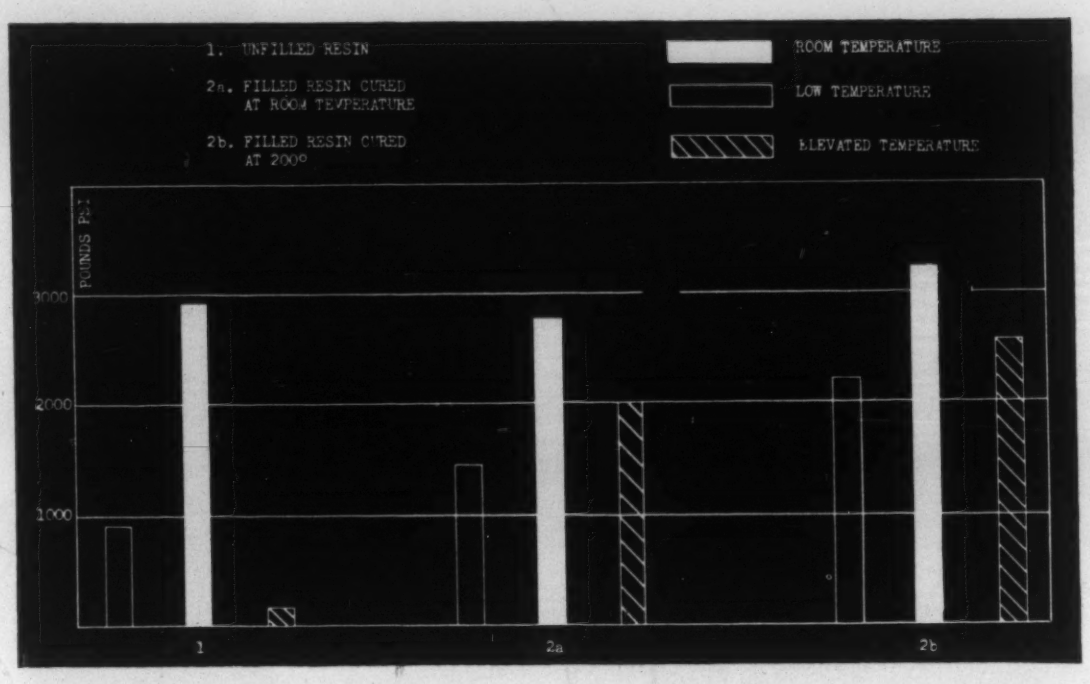
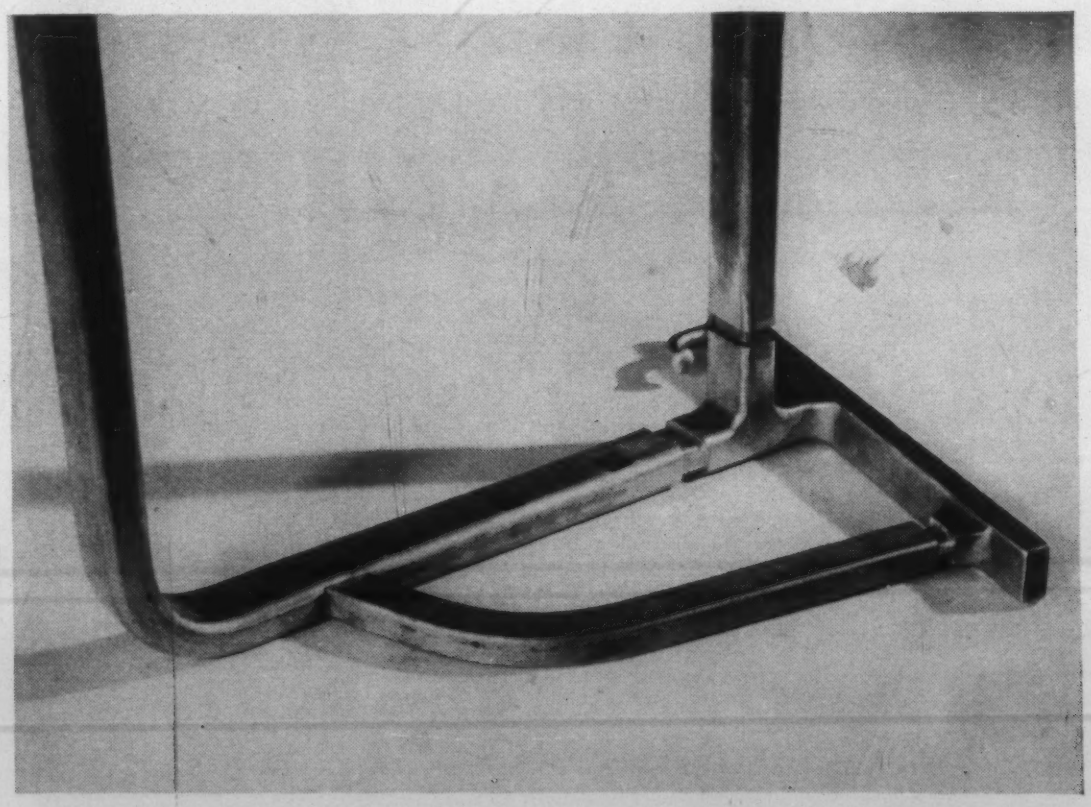
**The opinions expressed are those of the author and do not necessarily represent the official views of the United States Air Force.**




***Temperature effects on two epoxide resins. Adhesive 1 is not the same resin formulation as adhesive 2, so the filler material may not necessarily be the cause of the improved high and low temperature properties, but the values given indicate the possibilities of epoxide resins now available.***



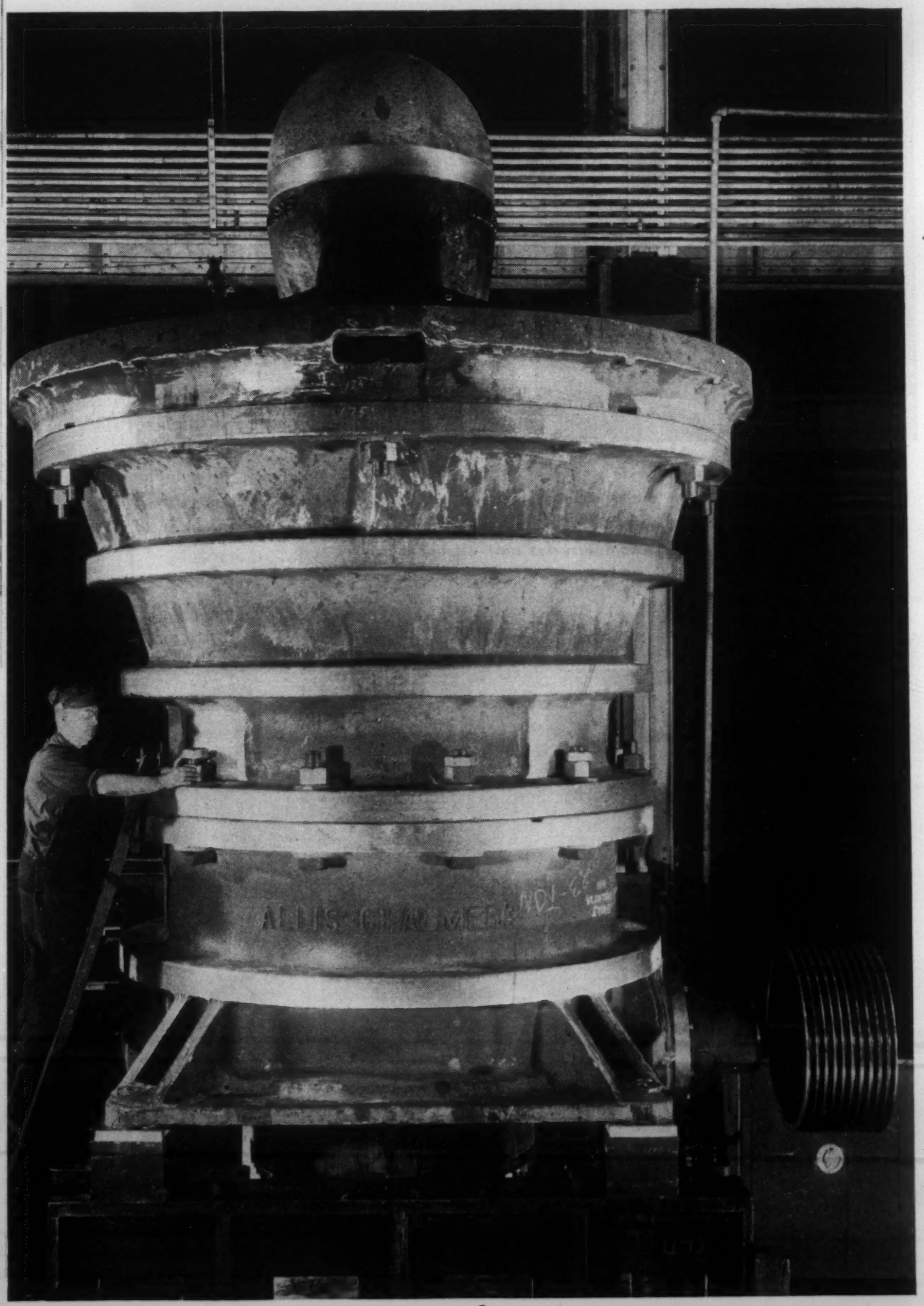
***A luggage rack for trains or buses is assembled with a new structural adhesive without any pressure application. (Ciba Co., Inc.)***

# Materials at Work

***Here is materials engineering in action . . .***

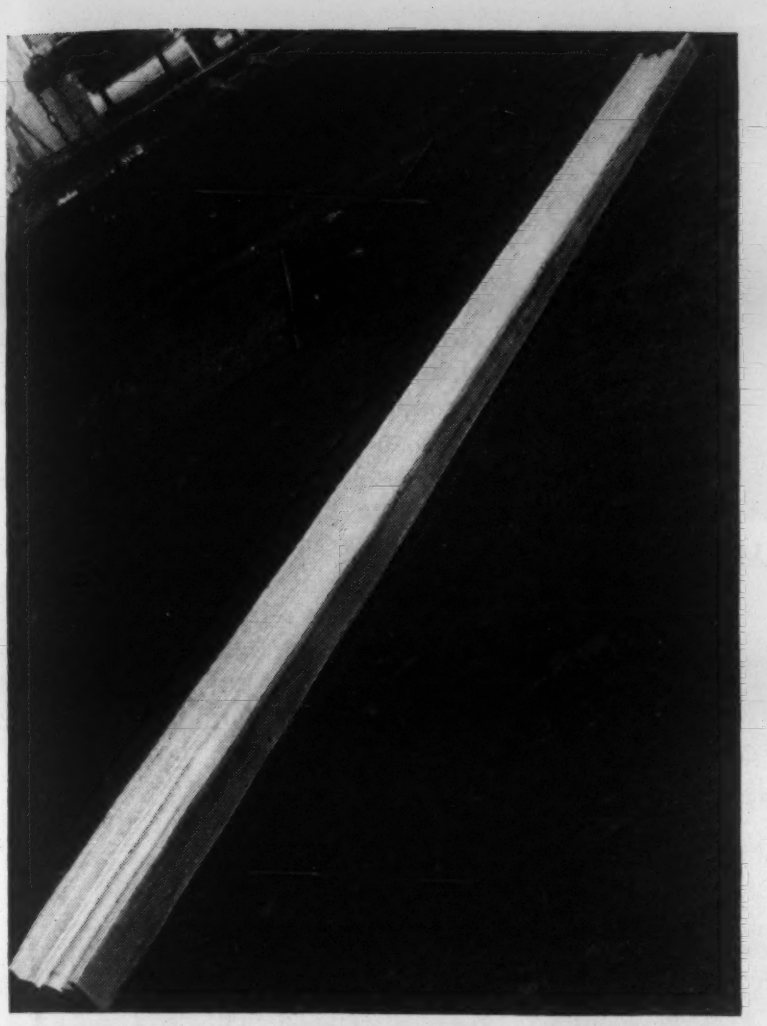
***New materials in their intended uses . . .***

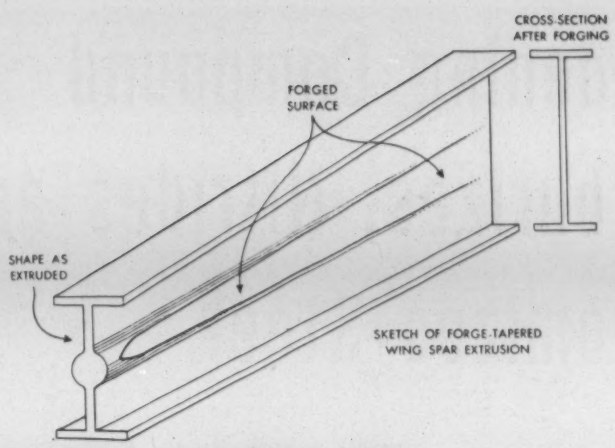
***Older, basic materials in new applications . . .***




## GYRATORY CRUSHER

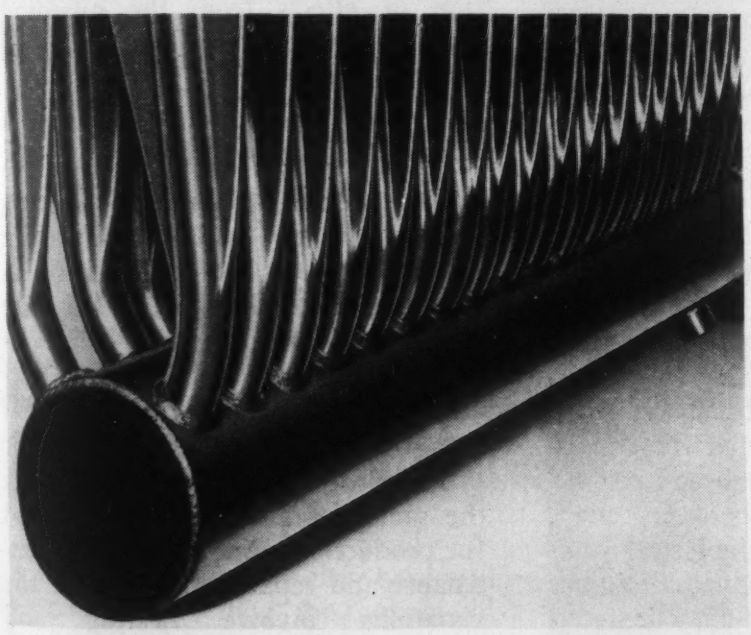
*The new Superior crusher was designed by Allis-Chalmers to take advantage of modern materials and constructions. The crusher is used to reduce bulk materials for the basic processing industries. The top and bottom shells are of cast steel, which has greater shock resistance than cast iron, can be welded and is now economical because of the diminishing differential between cast iron and cast steel prices. These shells are reinforced with horizontal annular ribs, designed to protect the casing against the cracks that stress analysis and experience show are inclined to occur in a vertical plane. The bottom shell has been shortened so that the concrete foundation in part replaces the relatively expensive casting. The dust seal has been designed as a replaceable plastic ring. The eccentric and the bottom plate are fitted with high-lead bronze bearings to extend the bearing life and allow the bearing surfaces to be renewed with a minimum of time and equipment. The gears and the main shaft are forged steel, while the concaves are manganese steel and are zinced in place by the user.*





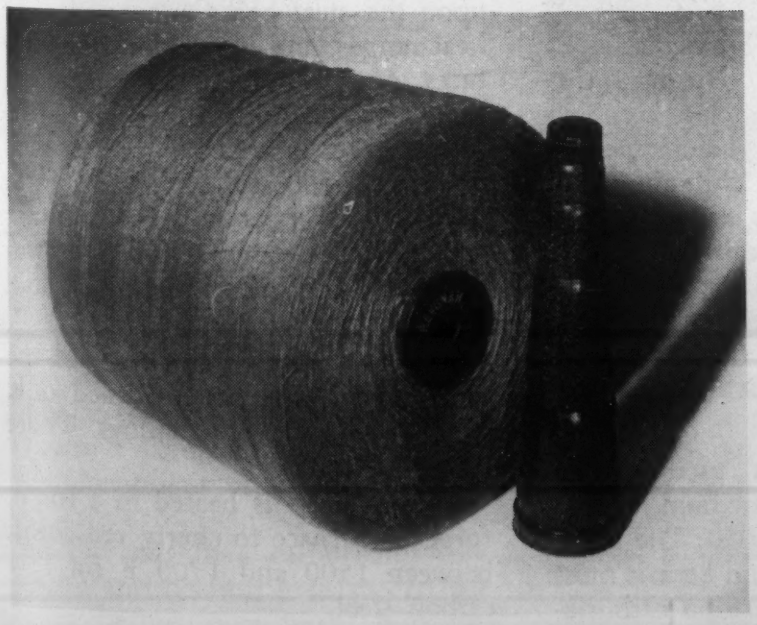

## FORGE-TAPERED ALUMINUM SPAR

*This one-piece tapered aluminum wing spar has been produced on an experimental basis by the McDonnell Aircraft Corp. and the Aluminum Co. of America. It replaces a composite assembly of riveted construction, is stronger, and saves 50 lb in the fighter plane weight. The spar begins as an I beam extrusion with a bulb in the web. This bulb is then progressively flattened by forging so that the finished spar web tapers from 10 in. at one end to 15½ in. at the other. After forging, the spar is machined, heat treated and stretched to produce the final part, 13 ft long, weighing 117 lb. Conventional spars are made of two T sections riveted together with small aluminum center plates to produce the taper. The new forge-tapered spar replaces about 50 parts, eliminating many riveting operations. The new solid section is stronger and there is little possibility of joint fatigue. Putting the bulb in the extrusion was the idea of McDonnell Production Manager Walter F. Burke.*



## TRANSFORMER RADIATOR

*Allis-Chalmers has evolved a new radiator design for transformer cooling. The new fins are formed from steel tubing and the ends are swaged to reduce the diameter at the point where they are welded to the header. The tubing itself is rolled to a modified oval cross-section to give more cooling surface. The new radiator is simpler, easier to paint, more rigid and quieter than previous designs. This method of using 16-gage seamless tubing was adopted after it became difficult to obtain the sheet steel previously used. The tubes were formerly made on automatic machines which feed the sheet through rolling dies, gradually forming it into a flat tube. A controlled weld then sealed the tube. The new design not only allowed the manufacturer to meet the present supply situation, but gave better performance as well.*



## RUBBER-PHENOLIC BOBBINS

*Jute bobbins are now being molded from G.E. rubber-phenolic compound, made by General Electric's Chemical Dept., instead of being made from wood. The new bobbins are stronger, lighter and lower in cost. The parts are molded by Jacobus Plastics, of Jacobus, Pa. With the wood bobbins formerly used, chipping and splitting often resulted from rough handling in weaving mills. With outstanding resistance to impact, the rubber-phenolic bobbins stand up under this severe abuse, besides saving 20% in weight on shipping costs. It is also easier to calculate shipping weights because the rubber-phenolic bobbins are more uniform in size and weight.*

# Hardening Compound Carburizes, Nitrides and Chromizes Steel

by E. M. ELLSWORTH, President, Doughty Laboratories, Inc.

***Fast acting steel hardening compounds are a recent heat treating development that harden cutting edges and increase wear resistance by three-way action.***

● A FAST ACTING case hardening compound has been developed which combines the advantages of carburizing, nitriding and chromizing. The entire treating process takes only a few minutes—the part is heated, coated with a paste or powder, the coating is fused for a few seconds, and the part is quenched. The surface of an easily fabricated, low carbon steel piece can be treated to obtain high hardness and abrasion resistance. No expensive heat treating equipment is needed. The part can be heated by a gas torch and dip or splash quenched.

The new compound is not designed to replace conventional pack carburizing or nitriding on mass production items where the parts must be hardened all over to considerable depths. On short production runs, on repair jobs and on parts that must be selectively hardened, however, the new compound will find many applications. It is marketed by the Doughty Laboratories, Inc., under the trade name Hard 'N' Tuff.

## How the Compound Works

Hard 'N' Tuff is essentially a carburizing compound. Special activating agents are added, however, to speed up the impregnating process and allow enough carbon to go into the steel surface in the few seconds the coating is fused on the hot piece to give high hardness on quenching. In addition to the carburizing ingredients, ammonium compounds are included to give a nitriding effect and complement the hardening action of carburizing.

These are both conventional techniques, however, although their combination in a powder treatment is rather novel. A more unique feature of the formulation is its chromizing action.

There are several points to be noted about this chromizing:

1. The heat treating temperatures used with Hard 'N' Tuff (1500 to 1700 F) are far below the usual chromizing range (2375 to 2550 F). The time of treatment is also a small fraction of that required for chromizing. As a result, the chromium content of the case is not very high, varying with the original steel composition. With an original chromium range of 0.02 to 0.05%, one treatment with the compound gives a content of 0.08 to 0.15%.

2. The chromium impregnation is not real chromizing. During infusion, the chromium tends to combine with the carbon (also being impregnated) to form hard chromium carbides. These carbides are objectionable in ordinary chromizing, making the coating brittle. In the small concentrations encountered here, though, they add considerably to the abrasion resistance of the carburized steel matrix.

The compound is used mainly with the low and medium carbon steels from 1010 to 1050. The steels are easy to fabricate and benefit most fully from the combination carburizing, nitriding and chromizing process. A low carbon 1020 steel can be brought from a Brinell hardness of 127 up to 600 by one treatment.

Excellent results can also be obtained on alloy steels and even high-speed tool steels. The most important alloys treated are the low carbon straight nickel specifications like the 2315-2512 class; the chromium-nickel alloys 3115, 3120 and 3312; chromium-molybdenum steels 4120, 4615 and 4815; and chromium-vanadium 6115. These steels develop high core properties, as do the carburizing grades 8617, 8620, 8715 and 8720.

The case is relatively thin, varying from 0.004 to 0.006 in. after one application. This can be increased by repeating the coating and quenching process several times, though. If even greater depths are needed, the compound can be used in conventional pack hardening, to give a case depth of roughly 0.030 in. after 30 min at furnace heat.

The treatment has also been found to add somewhat to the corrosion resistance of steel. This is a combination of effects from the nitriding and, perhaps, from the increased chromium content.

## How to Use the Compound

No special production heating equipment is needed—an open forge, a gas and oxygen torch or an acetylene torch is sufficient in most cases. An electric furnace or an induction coil can also be used, if they are available and their employment is customary.

The procedures used are basically the same for all types of steel and for production work as well as maintenance and repair jobs. Most of the variations involve heating and quenching procedures that depend upon the steel being processed. The heat ranges, and the critical temperatures of tool steels in particular, should be carefully noted since the temperature just below the critical point is the best heat at which to quench a piece. It is also important to follow the manufacturer's recommendations on quenching fluids—oil, brine or lead.

The procedures followed with the low carbon steels are modified only slightly for the higher alloys. There are five steps:

1. The piece is heated in a torch, forge or furnace to cherry red color, between 1500 and 1700 F for low carbon steel.

2. The hot piece is then dipped

or rolled in the compounds to pick up a coating.

3. The coated piece is taken out of the compound and the coating is allowed to fuse and form a crust. This fusion takes place in 15 to 30 sec, the larger the object the longer the time required.

4. The piece is then reheated at cherry red temperature, 1600 to 1700 F, to fuse the compound and absorb it into the metal surface. The time required depends upon the size of the object and is determined by observation.

5. The piece is quenched quickly —in cold water or brine for low carbon steels. A hose or splash quench can be used for large objects.

If a deeper penetration is required, steps 2, 3 and 4 can be repeated before quenching.

High carbon steel parts are heated in the same way, bringing the piece to cherry red temperature, 1425 to 1625 F, and fusing the compound coating. With these high carbon steels, however, the cutting tip or wearing edge is first quenched in brine, and then the whole piece is drawn and tempered before completely quenching. This procedure gives long cutting life and still retains malleability and ductility in impact and abrasion resistant tools.

When this compound is used on production parts, time studies become important since the processing time is cut from several hours, the time required for conventional batch hardening, to a few minutes. This decrease in operating time makes the time taken for feeding and handling important in overall costs.

In case hardening high-speed tools which have previously been hardened by any other method, the tool should be completely annealed before using the new compound.

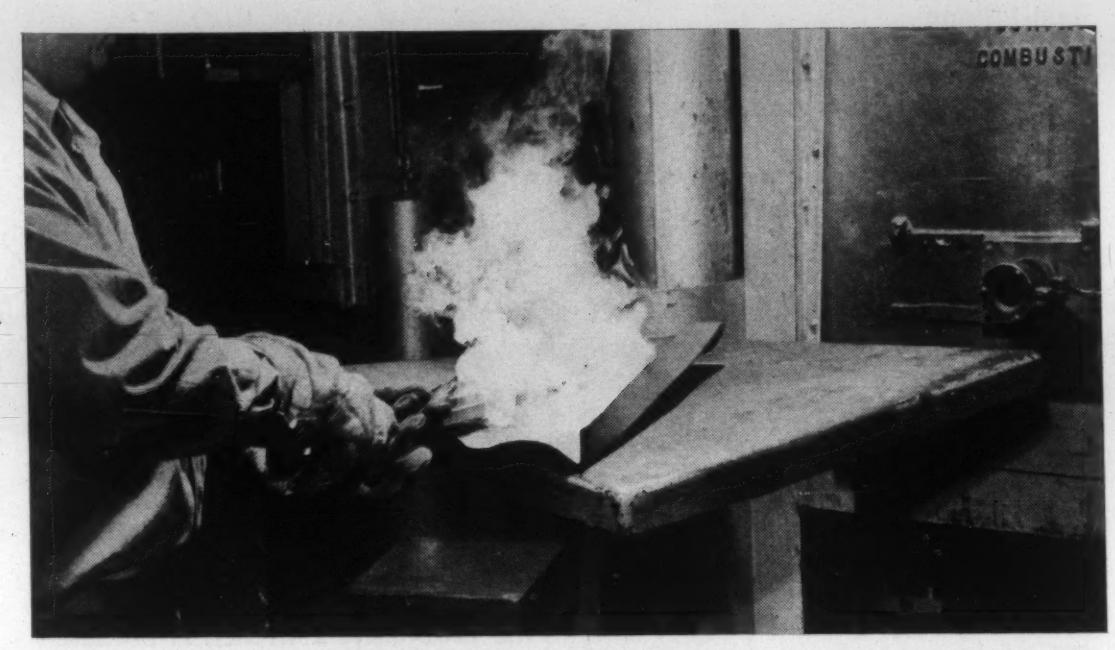
## Advantages

The principal advantages of the new compound are the relative simplicity of the equipment and techniques required to use it. The time required to case harden a piece is also much less with the new compound.

Conventional case hardening is done in several ways, all of which require comparatively expensive equipment and often take hours to do. Pack carburizing is done by packing the part in a carburizing compound and heating it in special furnaces before quenching. Nitriding and cyaniding take comparable time periods and require controlled atmospheres or special dips. The new compound, on the other hand, can be used with almost any heating technique and requires almost no special equipment. The time advantage is obvious. With conventional processes, the part must be placed in a packing box or a controlled atmosphere and furnace heated, while the combination compound can be used without moving the part. This is a tremendous advantage with heavy dies and similar parts.

Selective hardening of only the critical areas on a piece is even more difficult with conventional case hard-

*The first operation in hardening an open end wrench made from boiler plate steel is to heat the jaws in an acetylene flame.*



*The hot jaws are then rolled in the compound to pick up a coating which fuses into the metal in a second heating operation.*

*The hot, coated jaws are finally quenched to give a hard chrome-carbon alloy surface that resists wear and scaring.*

ening methods. The areas that must remain ductile can be protected by sand packs, special cements or temporary copper electroplating. The same result can be achieved by machining off the hardened layer in the place where it is not wanted. All of these methods are expensive and slow. The new compound is much easier to apply in selective hardening. One technique is to coat only the areas that are to be hardened with the compound before quenching. If the dimensions of the hardened area must be held to close tolerances, masking compounds or impervious cements can be used.

## Limitations

The time required to heat each piece for case hardening must be considered in totalling up the overall time saving with this compound, of course. This heating time detracts something from the apparent speed of the process shown by a simple comparison between conventional carburizing times and the few seconds required to apply and fuse the Hard 'N' Tuff coating. On production setups, the time saved is still considerable, however.

An even more important disadvantage is the relatively high cost of the new compound. In ordinary pack hardening, such a paste or powder could never replace the cheap, reusable carburizing compounds that are ordinarily used. In selective hardening, where only a portion of the piece is to be treated, however, the cost of the compound is easily justified by the speed and simplicity of the process. For shop hardening of dies and tools, the material cost is also a negligible factor. The cost of the compound is also no real limitation in field hardening replacement parts. The expense of the time lost in waiting for shipment of special alloy parts more than covers the price of the compound.

Another serious limitation is the relative thinness of the coating put on by a single treatment. Where a deep case, in the order of 0.03 is required, conventional pack hardening or nitriding is probably more economical than repeated treatments of the new compound—or using it as a packing material. In many cases, however, a very hard thin case over a ductile core is all that is required to prolong the life of cutting edges and wearing surfaces.

Coating the parts with powder or paste presents some difficulties in mass production. Where a very large number of pieces are to be processed at once, it may be difficult to get full coverage of each piece, keeping them at the elevated temperature. Experience and production ingenuity should overcome these troubles, however. One solution is to coat the parts at about 300 F. The coating will stick at this temperature and the part can be brought up to the fusing temperature and quenched without another interruption.

## Applications

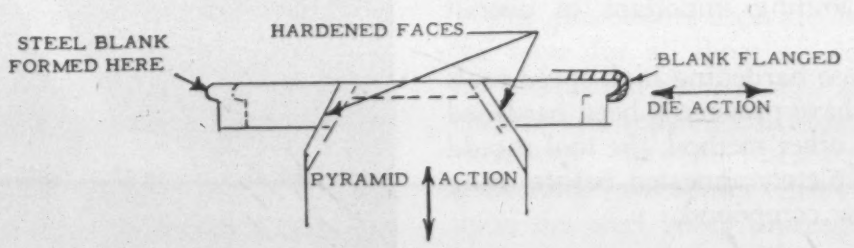
A demonstration of the hardening capabilities of the compound is given by treating a chisel made from ordinary low carbon 1020 ½-in. drill rod. The chisel is first shaped and sharpened, then forge heated, treated with the compound, and drawn to pigeon blue. This chisel can then cut in two a nut rusted firmly on a bolt with two blows on either side of the nut. After this cutting job, the edge of the chisel shows no damage and will still shave a finger nail.

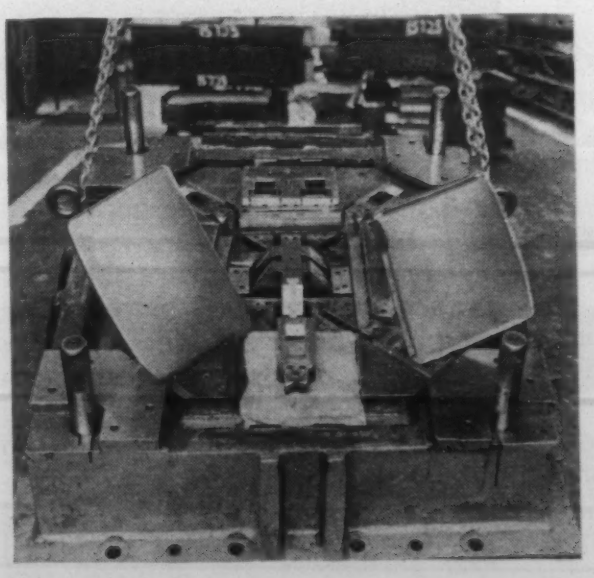
A similar production operation on large open end wrenches made from boiler plate steel gave equally good results (Fig 2, 3, 4). When these wrenches are carburized and hardened all over, the case on the handle chips under the hammer blows. By using the hardening compound on the jaws only, a wrench is produced which will stand up for a longer period with a combination of a tough handle and hard, long-wearing jaws.

Several examples can also be given of applications that were performed on machine and tool repair jobs.

A recent report from Colorado states that experiments show that percussion drills given two applications of the new compound gave five times as much drilled footage in abrasive rock as standard hardening methods. Three applications gave ten times as good results. Rotary drilling tool steel inserts treated with three applications gave 90% as good results as tungsten-carbide inserts. The tungsten-carbide inserts will also break and chip eventually, where the treated tool inserts do not break or chip and can be resharpened and retreated. The difference in cost between $64 for a tungsten-carbide insert and $12 for a treated tool steel insert gives an indication of the economies provided by correct usage of the compound.

The foregoing applications and the type of results achieved should point the way toward a more extensive use of chemical compounds since it is now established that these materials provide a very definite series of advantages. Considerable investigation remains to be done, however, in the study of the results of the alloying action which accompanies treatment of various metals. It would appear that the opportunities for the use of unalloyed low property materials which, when treated, can provide the high properties of costlier processed metals, might be extended beyond the tool shop or maintenance department. Under today's conditions these opportunities might prove of even greater interest.



*The pyramid surfaces on this cam die are subject to wear. The vertical movement of the pyramid forces the inner die sections out to form the blank. The original worn boiler plate pyramid was reground and treated for hardness, and turned out 256,000 panels without appreciable further wear.*

# How to Overcome Materials Shortages

## in Product Design and Manufacture

by H. R. Clauser,
Managing Editor,
Materials & Methods

Materials & Methods Manual
No 72 • July 1951

Today engineers, designers and production men are faced with the serious problem of continuing the manufacture of military and civilian products despite shortages of most of the common engineering materials. This 32-page article is intended to help those faced with this problem by bringing together in one place the following information:

- Ways and means of overcoming materials shortages.
- Suggestions on conserving or replacing specific scarce materials.
- Where and how alternate materials can be used.
- Case histories describing how some leading manufacturing companies are licking the shortages problem.
- Reference table listing specific alternate materials for specific products.

Today practically every engineer and designer in the manufacturing industries is faced to a greater or lesser degree with the same troublesome problem—materials shortages. Starting with scarcities here and there during the last half of 1950, the shortages have spread from one engineering material to another until now, hardly a year since the present emergency began, even some materials relatively plentiful in the last war are no longer on the available list.

Yes, the problem of materials shortages is a serious one, and it will be with us for some time to come. But there are ways to overcome materials shortages, and they are being put into practice, as we found by visiting many plants and by talking to many engineers who are faced with the problem of continuing production in spite of the shortages. The solution, very briefly, lies in practicing even more strictly than before good materials engineering, which in essence is the selection of the best *available* material to produce the highest quality product at the lowest possible cost. Thus, during this emergency period it means a continuing reappraisal of the possible engineering materials that can go into a particular product in light of what materials are available at the time.

What are the ways to overcome material shortages? There are a number of ways as listed below.

1. Stretch your available supply of scarce materials. This can be done by:
   - Simplification
   - Reduction of waste
   - Reclamation of scrap
   - Salvage of rejects
   - Using less scarce material per item
   - Using a combination of the scarce and a more plentiful material
   - Using a more plentiful form of the material

2. Use a down-graded composition of the scarce material.

3. Change to another more plentiful material. This can be done by:
   - Using an alternate material with or without design changes.
   - Using an alternate material plus processing, such as heat treatment, to obtain desired properties.
   - Using an alternate material plus a surface finish or treatment.

As was learned from experience during World War II and again in the present period of scarcities, change-overs from one material to another produce varying results. In more cases than is often realized, the replacement material proves to be superior to the scarce material it replaces, and, consequently, continues to be used even when the former material again becomes available. Through-out this article there are many outstanding examples of just this.

For this reason we will try to avoid the use of the word *substitute* and instead use *alternate* or *replacement.* To many people the word substitute implies an inferior material or a temporary change.

There are cases, of course, where a change of materials brought on by the shortage means a lowering or a sacrifice of one or more service properties, or a higher total cost due to higher material and/or processing cost. And there are cases where it is necessary to compromise quality or service life by using down-graded compositions of scarce alloys. But each case must be considered on its own merits. Whether or not an alternate becomes the permanent or the standard material in a product depends on its actual performance, its cost, and its ease of processing. If if proves better in these respects it will stay; if not, it will be replaced when the other material becomes plentiful again.

The problem of alternates is not static; it is ever changing, as was clearly demonstrated during the last war. With materials supply and demand constantly fluctuating, what may be an alternate material this month may become a critically scarce material the next. Often the very fact that a material is available as an alternate causes it to come into great demand and precipitate a shortage. Thus, in 1942 wood was considered a good alternate for steel in many products, but in 1943 when wood became scarce and steel became more plentiful, steel served as an alternate for wood.

# Ways to Stretch Scarce Materials

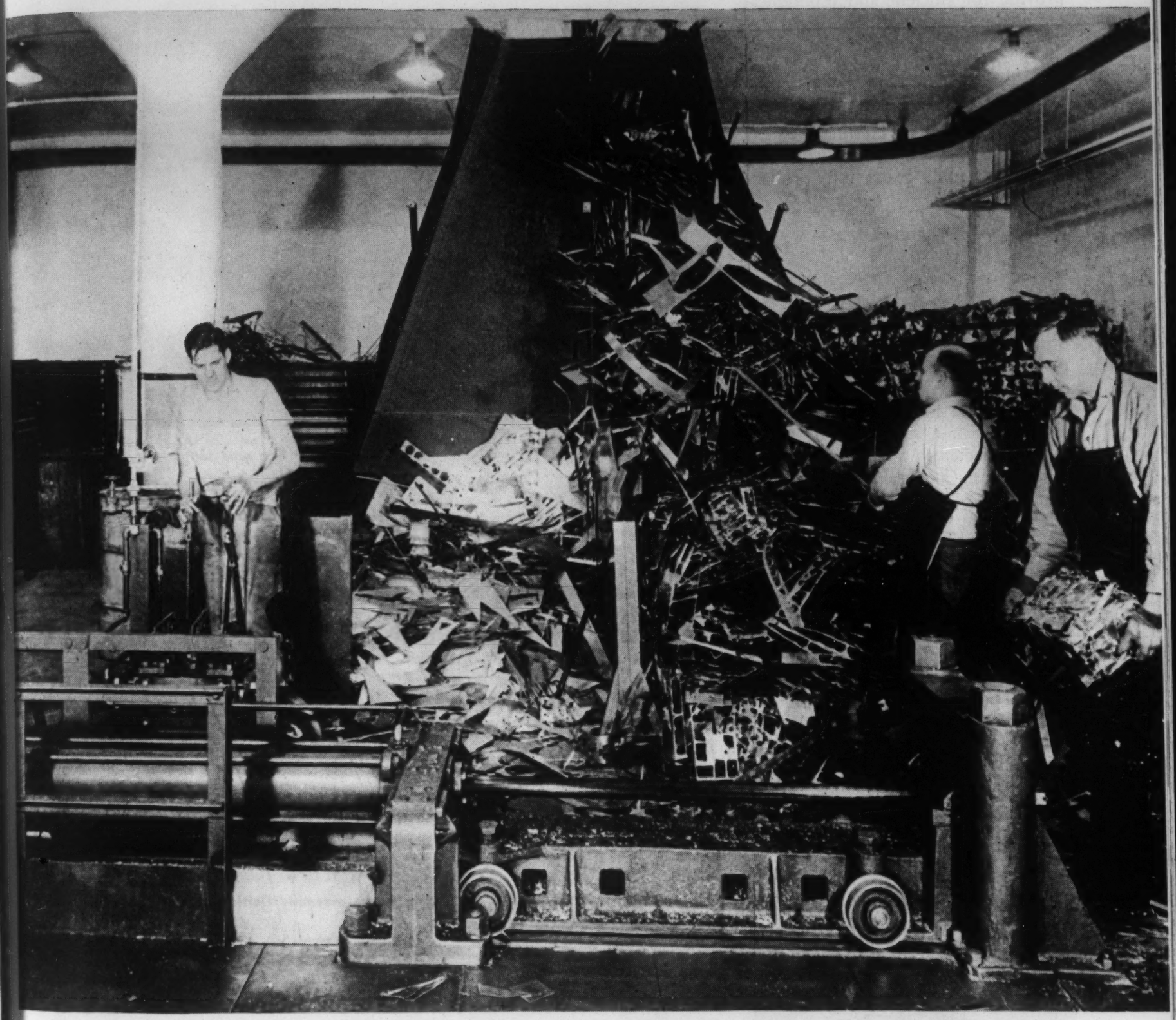
The first step in overcoming material shortages is to make your materials go further. Practice conservation. This is true whether you must work with limited supplies of the controlled or allocated scarce materials or must rely completely on alternate materials. Remember that practically all materials are short, and so conservation must be practiced on all of them.

There are a number of measures that can be taken to conserve and stretch available supplies of materials. The principal ones will be discussed here briefly in order to give some idea of what can be accomplished.

## Simplify

One of the first steps to make available or allotted supplies of materials stretch further is to put into practice a strict simplification program. This means surveying the entire line of products produced for the purpose of reducing excessive variety of sizes, types, grades and models of products. By such a program, the items most widely used and most economical in use of scarce materials can be retained, while those using relatively large amounts of short materials can be discontinued, at least for the present.

During World War II many companies and entire industries accomplished great savings in materials by simplifying their product lines. For example, the number of different iron, brass and bronze valves was reduced from 4079 to 2504. This reduction resulted in annual savings of about 650 tons of carbon steel, 4340 tons of alloy steels, and 1900 tons of copper. The sizes and weights of certain types of cast iron radiators were reduced, with a consequent saving of 23,000 lb of cast iron per year. The variety of range boilers was reduced from 156 to 12, and expansion tanks from 13 to 5. This



*A thorough going salvage program is one of the first steps towards overcoming materials shortages.*

program made mandatory the use of standard steel sheets of 60-in. width without shearing or cutting waste. Estimated savings: 10,000 tons of sheet steel and 2925 tons of cast steel and iron.

Shortly after the present emergency began, a leading hardware manufacturer started a simplification program that reduced variety from 1000 items down to 100. As new production restrictions are put into effect, their line of products is re-examined to further simplify for the additional reduction of waste.

A division of simplified practice has been operating in the Department of Commerce for a number of years now, and stands ready to assist industry in establishing simplification programs.

A good simplification program will also include the reduction of an excess variety of materials, and different grades, sizes and shapes of materials. This will eliminate inventories of little used materials and all the waste usually connected with unnecessary variety. In carrying out a materials simplification program, the following general principles should be kept in mind: (1) Satisfactory and sufficient variety of grades and sizes should be available to accomplish the engineering result. (2) Rational selection of grades and sizes should be made to provide sufficient range of quality and quantity in economical steps. (3) Standard grades and sizes should be selected in line with national or trade practices to provide maximum availability. (4) Where more than one plant is involved, simplification should be coordinated between plants to provide for exchange of stocks. (5) Adequate information should be furnished to all operating and engineering departments. (6) The program should allow for the addition of promising new items when de-

sirable. (7) The program should provide for efficient and economical elimination of superseded items.

Finally, the design of individual parts and products should be simplified wherever possible. Products should be analyzed and redesigned where necessary to eliminate excess material and make most efficient use of the materials going into production.

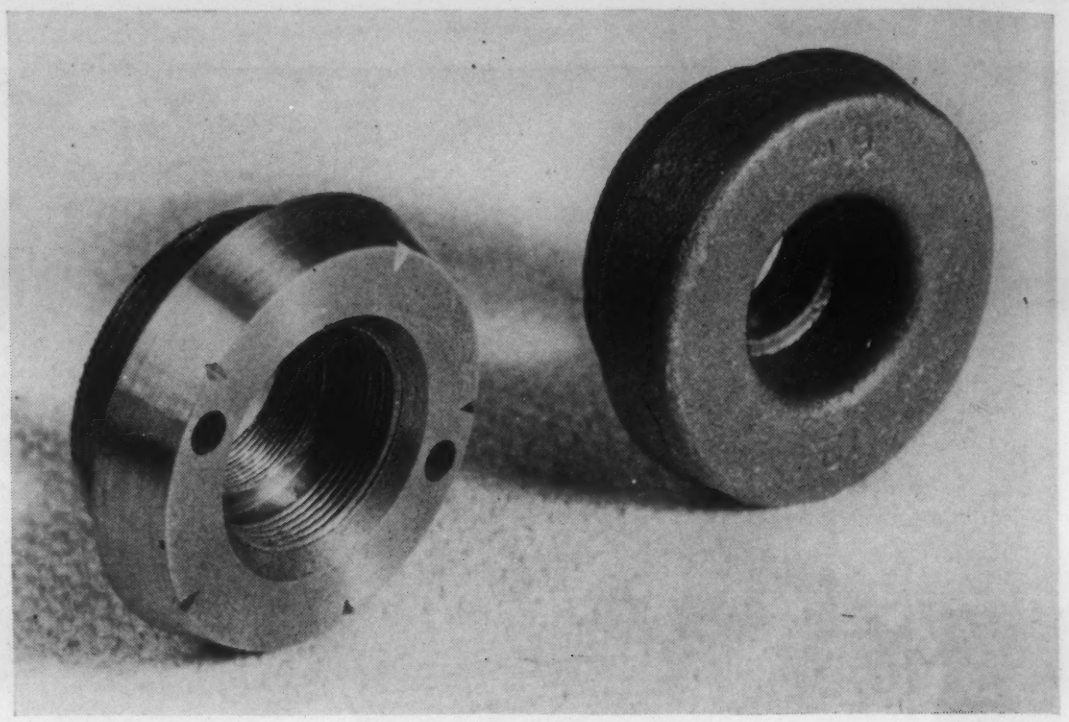
## Reduce and Reclaim Scrap

Another means of stretching available supplies of materials is to eliminate waste and recover scrap. A thorough-going salvage program is particularly important where use of certain scarce materials is permitted but supply is limited. By using the material with a minimum of waste and by efficiently collecting and reusing scrap, available supplies can be made to go further. One automobile company figures that by reworking its sheet scrap it can make about one extra car for every 50 produced. This same company is reusing about 22% of its sheet clips for such things as washers, caps, flanges, brackets and cover plates. One refrigerator plant is returning almost 3500 tons of pressed metal rejects, shearings, etc., per year to the productive cycle.

In order to make best use of scrap, such as shearings, skeletons, trimmings and bar ends, it is sometimes desirable to change the design. For example, a slight change in the design or shifting of a layout of a stamping may result in a larger and more usable skeleton or trimming. Modification of tool design may permit use of a shearing or offal piece without the necessity of first trimming or blanking the piece. Slugs or blanks of uniform size from press operations can often be magazine-fed in the press production of smaller parts.

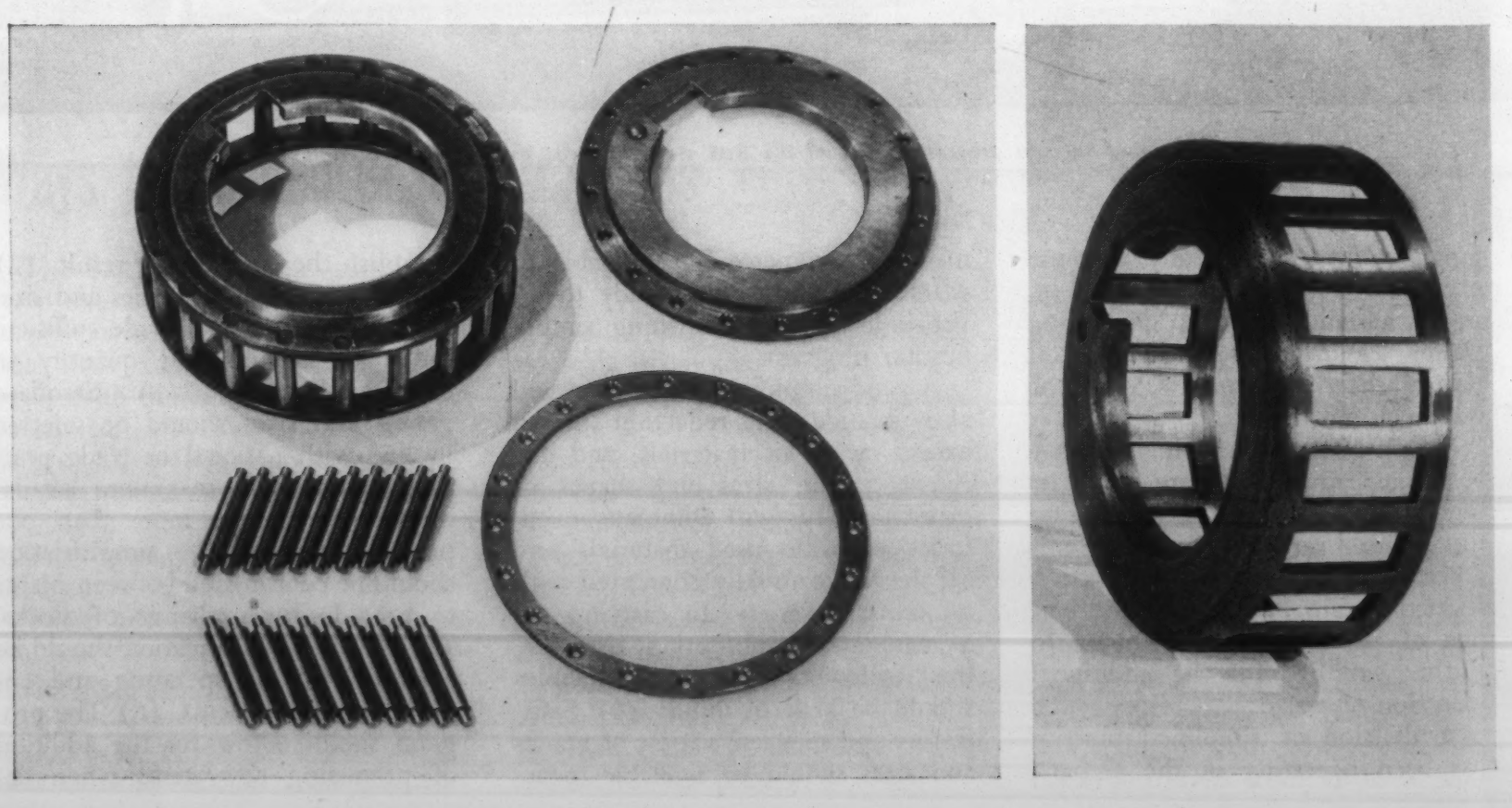
Obsolete metal stock, such as tubing, sheet and rod, can often be used to advantage instead of discarding. Frequently it can be adapted for productive use elsewhere or used for nonproductive purposes by the maintenance department.

Scrap also can be reduced by salvaging rejected parts. Here success depends upon working out repair methods that will not increase costs excessively and yet will repair the part satisfactorily. Where parts are being repeatedly rejected, the effort



*This 5-in. anti-aircraft shell adapter made of malleable iron was formerly machined from steel bar stock. (Malleable Iron Founders' Society)*

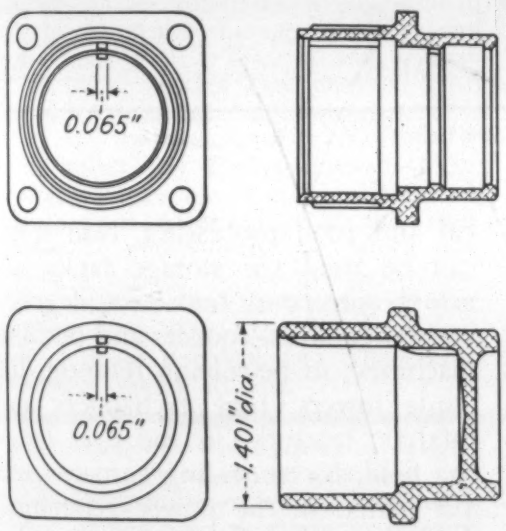
*Considerable material saving was realized by redesigning this roller cage from a machined assembly (left) to a one-piece stamping (right). (Leake Stamping Co.)*



of developing a good repair procedure will be repaid by substantial savings in material. For example, scrap was high on a certain bearing plate in a refrigerator due to a flapper valve seat not cleaning up because of shrink holes in the castings and some over-size bores on the valve cavity. It was found possible to make the bore 0.020 in. larger, and to drop the seat 0.050 in. A larger and deeper salvage valve retainer was then used. The result was that 95% of the bearing plates were salvaged.

## Redesign to Another Form

Converting from one metal form to another is another means of using less material or reducing waste. Machined parts should be replaced wherever possible. Stampings can often replace forgings to advantage. And castings can often replace fabricated assemblies. There are any number of examples to illustrate such conversions, but space permits the mention of only a few.




*Scarce aluminum was saved by Bendix Aviation Corp. by redesigning this watertight connector for an extruded hot die pressing (bottom) instead of a machined part. (Scovill Manufacturing Co.)*

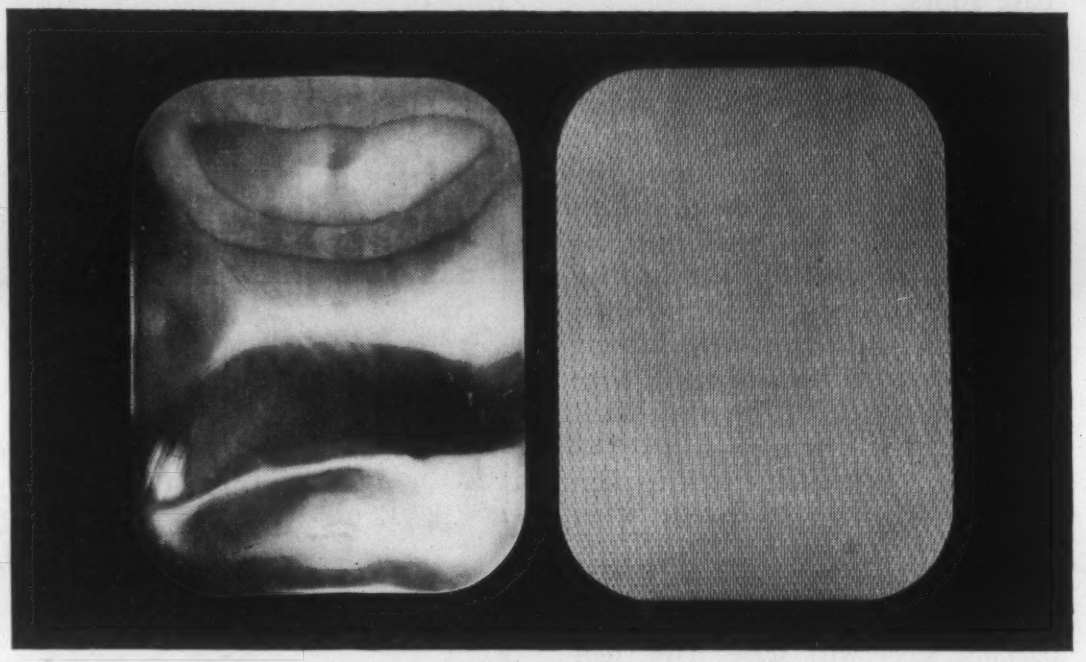
A 5-in. anti-aircraft shell adapter was originally machined from steel bar stock weighing 3¾ lb. Because of the scarcity of steel and machine tools, a malleable iron casting, cast close to size and weighing about 2¼ lb, was adopted.

With stamping techniques substantial savings of raw materials are often possible. A torque converter roller cage was formerly an assembly of 22 parts. Besides two rings, there were 20 hardened and ground Torrington pins with soft shouldered ends, each of which had to be riveted at both ends in assembly with the rings. This assembly was replaced by a one-piece stamping, as shown, resulting in a considerable saving of material. In another case, a bomb fin crate locknut assembly was replaced with a stamped clip, making possible material savings of over 1/3 lb of steel per unit.

An interesting case is that of an aluminum water-tight connector used in electrical systems of air-borne or land vehicles. One member is a thin aluminum shell with a square flange. The pilot lot was turned from bar stock and the inside diameter and key were broached. The finished piece weighed about 0.057 lb, and there was a scrap loss of nearly 0.40 lb. Because of the vibration to which such parts are subjected, the only other satisfactory method was an extruded hot die pressing. By this method, the weight of the rod required is only 0.136 lb per piece compared to 0.454 lb for the machining method. Thus, the saving of aluminum realized was 0.318 lb per piece.

In many applications powder metallurgy parts in place of screw machine parts offer materials saving possibilities. On such parts as pistons, gears and cams, the finished parts can be produced by powder metallurgy without any subsequent machining.

Precision casting also can often reduce materials waste and release



*Thinner sections can be used with "rigidized" sheet metals. Also, dented, scratched, bent, or otherwise damaged cutouts and blanks (left) can frequently be salvaged by "rigidizing" them (right). (Rigidized Metals Corp.)*

performance improved.

Another means of conserving scarce metals is to use extruded shapes. In recent years there has been a growing use of extrusions in aluminum, magnesium and several copper-base alloys. Within the last year or two, the extrusion process has been extended to steel. All types of complicated shapes can be produced, most of which save large quantities of metals which otherwise would be wasted in machining.

By using "rigidized" sheet metals, increased strength and flexural rigidity is obtained which can be translated into the use of thinner sections. For example, by using rigidized metal for railway coach wainscoting, it was possible to cut the gage from 0.090 to 0.060. This also permitted the removal of some of the supporting structures, further reducing the amount of material required.

## Use Composite Metals

Clad or composite metals offer an important method of stretching available supplies of scarce metals. Wherever stainless steels, nickel and nickel-

base alloys, copper and aluminum are used in plate, sheet or strip form, composite metals should be considered as possible alternates. Savings of critical metals realized by using clad metals have been as high as 90% in some instances. The chart shows the savings in pounds per 100 pounds possible by substituting a single clad steel for solid stainless steels, nickel and nickel-base alloys.

There are many types of composite metals. The most common are the clad steels, which consist of a commercial grade steel plate, to one or both sides of which is permanently joined a cladding of another metal or alloy. Generally, plain low carbon steel is used for the backing, while the cladding consists of stainless steel, nickel, monel, Inconel, copper, cupro-nickel and silver. Practically all types of stainless steels can be had in clad steel form. Clad steels are now available in strip from 0.01-in. thick up to plates 5 in. thick.

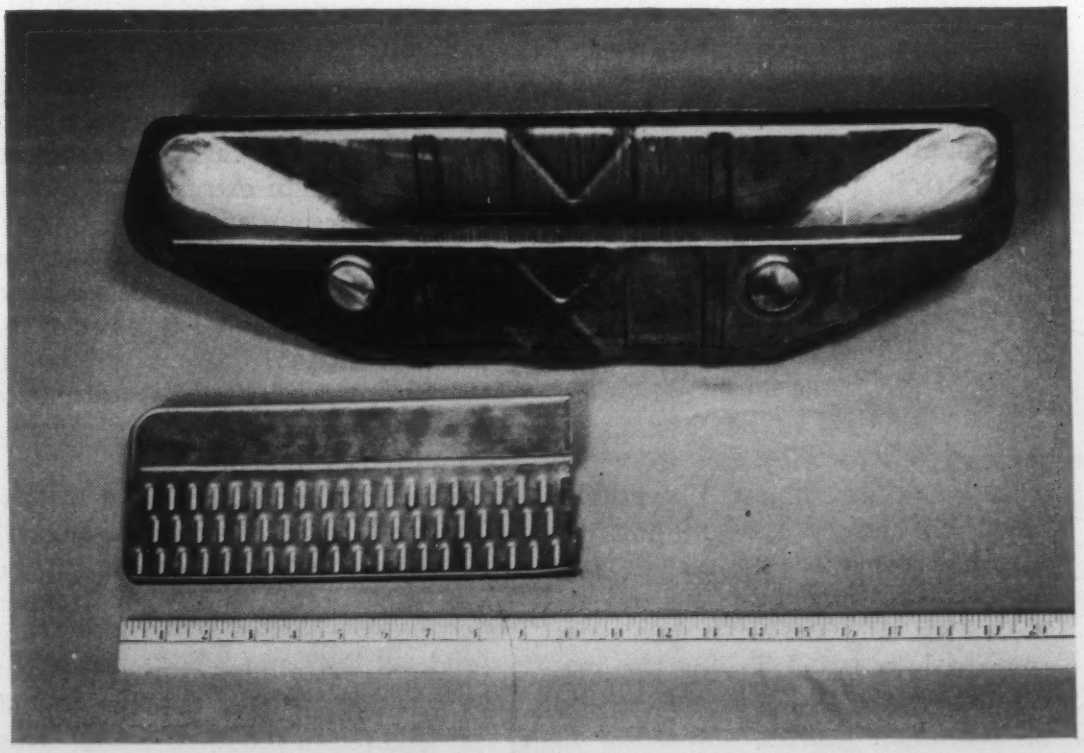
In general, single clad steels cannot be used above 1000 F since the backing steel will scale. Low temperature applications are generally limited to −50 F. Clad steels are usually fabricated by welding. For corrosion resistant applications, proper precautions must be taken to avoid or minimize dilution of the weld metal by pickup of the backing steel. Otherwise, corrosion resistance at the joints can be sufficiently lowered to cause failures.

Clad steels already have been used quite extensively in industry. Space permits listing only a few typical fields of application to give some idea of their usefulness. In chemical and food processing, clad steels can be used for storage tanks, reactors, autoclaves, tank cars, degreasers, evaporators, cookers and bottling machines; in petroleum refining, for crude towers, heat exchangers and catalytic reactors; in the heat treating field, for annealing furnaces and salt baths; in the power generating field, for coal chutes and condensers.

**Savings in Pounds per 100 Pounds Possible by Substituting Single Clad for Solid Material**

| Type Cladding | % Clad | Amount Saved, Lb per 100 Lb | | | |
|---|---|---|---|---|---|
| | | Nickel | Chromium | Copper | Columbium |
| Nickel | 5 | 92.30 | ..... | ..... | ..... |
| | 10 | 85.20 | ..... | ..... | ..... |
| | 20 | 71.00 | ..... | ..... | ..... |
| Monel | 5 | 62.20 | ..... | 27.86 | ..... |
| | 10 | 57.50 | ..... | 25.70 | ..... |
| | 20 | 48.00 | ..... | 21.44 | ..... |
| Inconel | 5 | 71.55 | 13.79 | ..... | ..... |
| | 10 | 66.10 | 12.58 | ..... | ..... |
| | 20 | 55.20 | 10.16 | ..... | ..... |
| Type 304 | 5 | 8.82 | 17.62 | ..... | ..... |
| | 10 | 8.14 | 16.28 | ..... | ..... |
| | 20 | 6.78 | 13.56 | ..... | ..... |
| Type 316 | 5 | 11.15 | 15.79 | ..... | ..... |
| | 10 | 10.29 | 14.57 | ..... | ..... |
| | 20 | 8.58 | 12.14 | ..... | ..... |
| Type 347 | 5 | 9.75 | 16.71 | ..... | 0.928 |
| | 10 | 9.00 | 15.43 | ..... | 0.857 |
| | 20 | 7.50 | 12.86 | ..... | 0.714 |
| Type 410 | 5 | ..... | 11.60 | ..... | ..... |
| | 10 | ..... | 10.70 | ..... | ..... |
| | 20 | ..... | 8.92 | ..... | ..... |
| Type 430 | 5 | ..... | 14.85 | ..... | ..... |
| | 10 | ..... | 13.71 | ..... | ..... |
| | 20 | ..... | 11.42 | ..... | ..... |

*(Lukens Steel Co.)*



***A radiator tank fabricated successfully of copper-clad steel saves about 70 to 80% copper. (American Cladmetals Co.)***

In addition to clad steels, composite metals can be obtained in almost any combination of metals or alloys. Some of these combinations include copper clad aluminum, silver clad aluminum, aluminum clad iron, nickel clad iron, and stainless clad copper.

Besides serving to extend limited supplies of critical materials, composite metals often contribute other advantages. By combining two or more metals or alloys, properties are often developed which are not available in single metals. Often, strength properties or other characteristics of composite metals are superior to the solid form so that lighter gages can be used. Also, in many cases, use of composite metals result in cost reduction.

Here are some specific examples

of where composite metals have been the means of conserving critically scarce metals.

Radiator tanks used in water cooled internal combustion engines have been fabricated successfully from copper clad steel. The particular type of radiator tank shown (tubes excluded) is made 0.025 to 0.031 in. thick. Since the copper or copper alloy cladding is usually thicker than that in the tubes, its service life is quite satisfactory. The amount of copper saved is approximately 70 to 80%.

In general, composite metals meet the requirements necessary for broad application throughout the hardware fixture industry. Illustrated in an accompanying photograph are the steps in forming the components of a drive-way lamp fixture. In addition to combining the strength of steel with the ductility and corrosion resistance of copper, this application of copper clad steel provides a saving of 80 to 90% of copper.

The radio tube industry uses large quantities of nickel for anodes. Because of the nickel shortage at least one major tube producer is now using aluminum clad low carbon steel. Normally, nickel is rolled to

## Redesign of Vital Components Required at Lionel to Stretch Scarce Materials

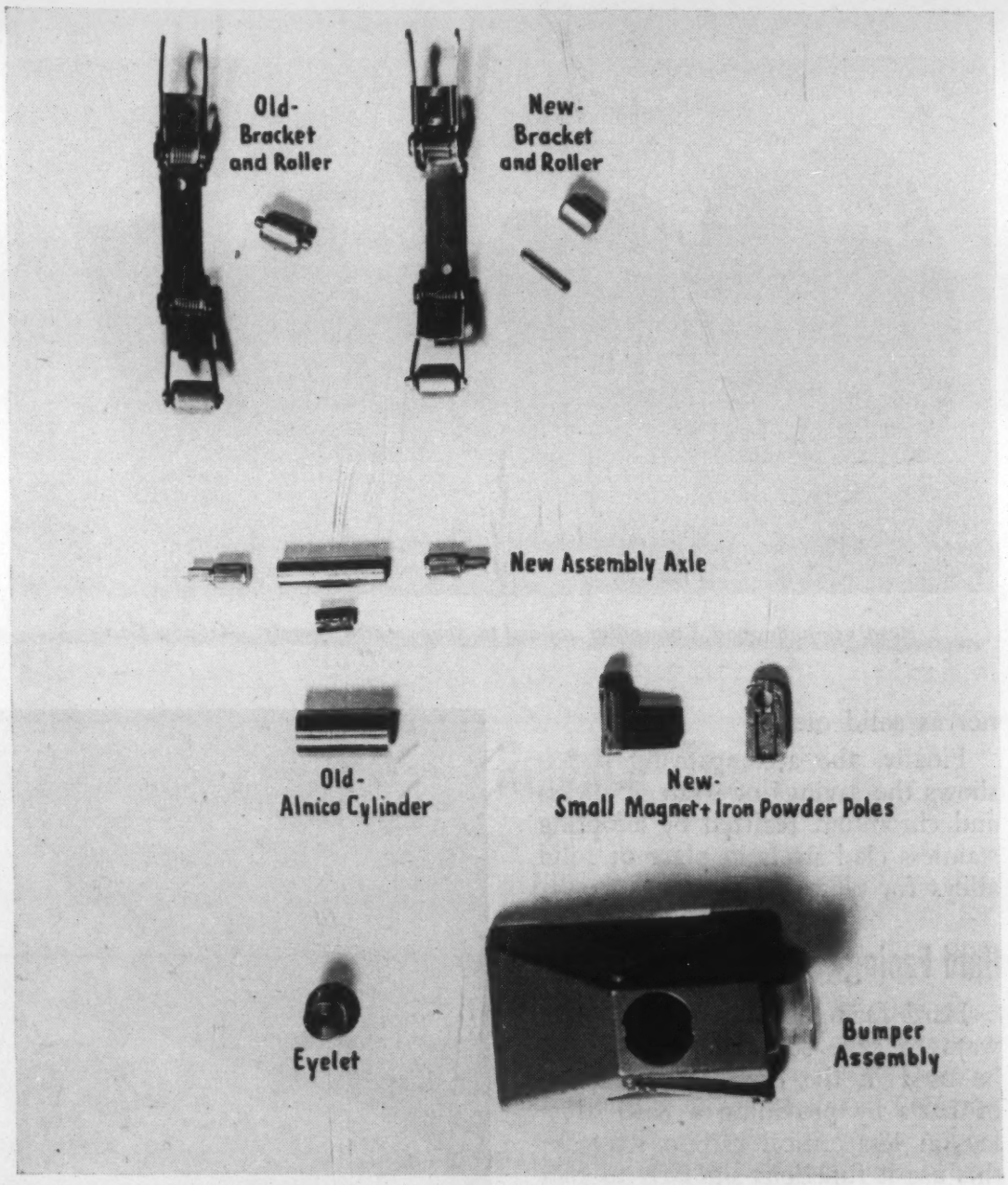
Many changes in materials have been required at Lionel Corp., makers of model trains, since the period of materials shortages began.

The contact roller on their motor trucks was formerly a screw machine part made of type 316 stainless steel; the roller bracket was made of phosphor bronze strip stock. The new assembly now consists of a metal powder roller—composition: 8% nickel and balance copper—and a cold rolled steel roller bracket. In the new design the roller has a longitudinal hole in the center through which a cold rolled steel pin is inserted and riveted to the roller bracket (see photo). This design has a number of advantages: (1) It reduces the amount of scarce material in the roller. (2) The pin instead of the bracket becomes the bearing surface, and thus permits substitution of the steel bracket for phosphor bronze, which was originally needed to provide good bearing qualities, arc resistance and good conductivity. (3) The life of the original unit is about doubled. (4) There is a substantial saving in cost.

One of the features of Lionel trains is "Magnetraction," which involves magnetizing the train wheels so that they will "stick" better to the rails. To maintain this feature it has been necessary to redesign in order to drastically reduce the amount of scarce magnetic materials used. On one motor truck model the 5/16- by 1¼-in. axle formerly made of Cunife (60 copper, 20 nickel, 20% iron) has been replaced by an assembled axle which uses a small Alnico magnet only ¼ by ⅛ in. The magnet is placed in a 5/16-in. o.d. tube of type 303 stainless steel, which serves as the axle. The ends are plugged with a knurled carbon steel pin (see photo). This redesign saves considerable nickel, also is 20% cheaper, and has much better magnetic properties.

On another model, a solid Alnico cylinder, ½ in. in dia and about ⅞ in. long, adjacent to the axle, provided the necessary magnetic properties. With this design, phosphor bronze axle bearings were required. The new design uses a small rectangular Alnico magnet, only 11/16 in. long, 7/16 in. wide and 3/16 in. thick, located between two iron powder poles which also act as bearings for the wheel axle. This change has eliminated the phosphor bronze bearings and saves 40 gm of Alnico material per unit.

Here are a few other changes Lionel has made:




*Design changes made by Lionel to overcome materials shortages.*

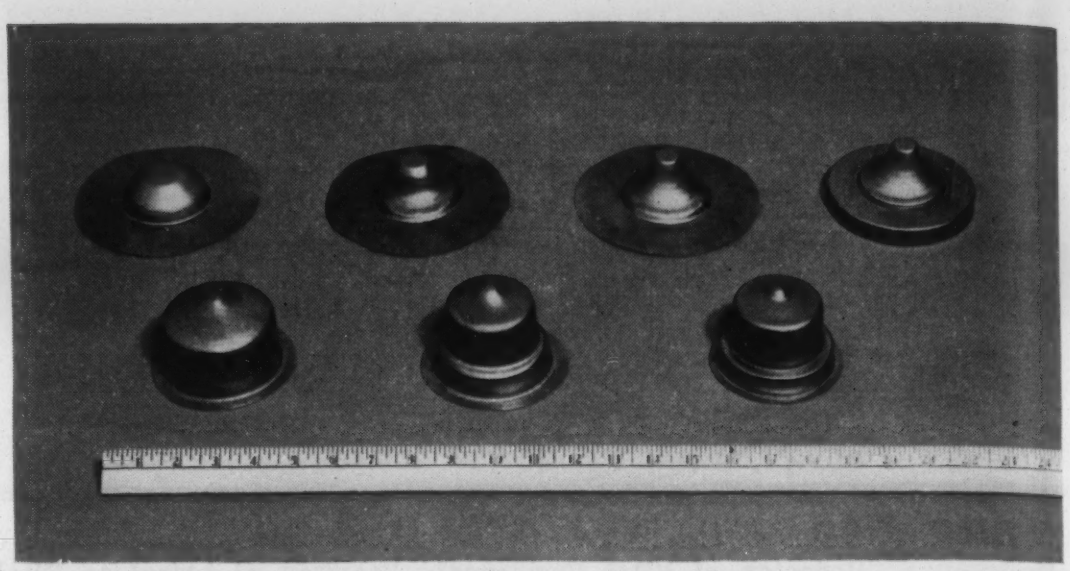
Most of the gears, formerly phosphor bronze and made of screw machined blanks with hobbed teeth, are now produced of various metal powder compositions including iron powder. Longer life is realized and machining waste eliminated.

A "bumper" assembly formerly a zinc die cast body with an aluminum screw machine button now is a plastic injection molding.

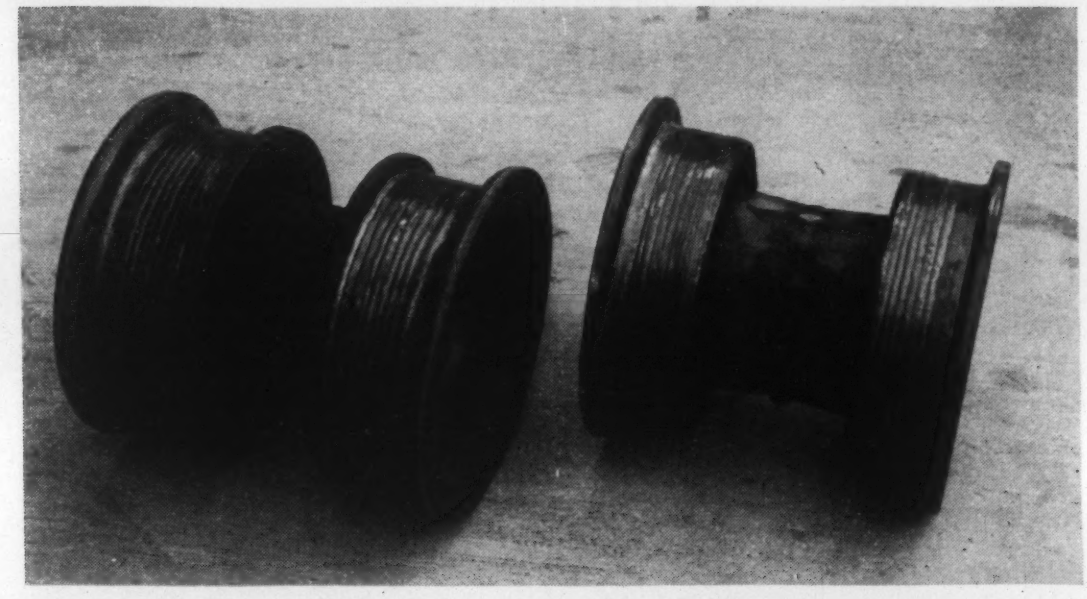
A large eyelet, originally a nickel-silver drawn shape because it had to be nonmagnetic and easily spot-welded, was replaced by an aluminum drawn shape even though harder to spot-weld. With aluminum short, the part was changed to a phenolic molding. The matched part had to be redesigned to permit press-fitting in place of spot welding.

the proper thickness, carbonized or blackened, and then formed into the anodes. Aluminum clad steel does not have to be carbonized. After the anodes are formed, they are heated to a temperature somewhat above the melting point of aluminum, at which time aluminum ferrides form on the surface, giving the parts radiation characteristics fully comparable to carbonized nickel.

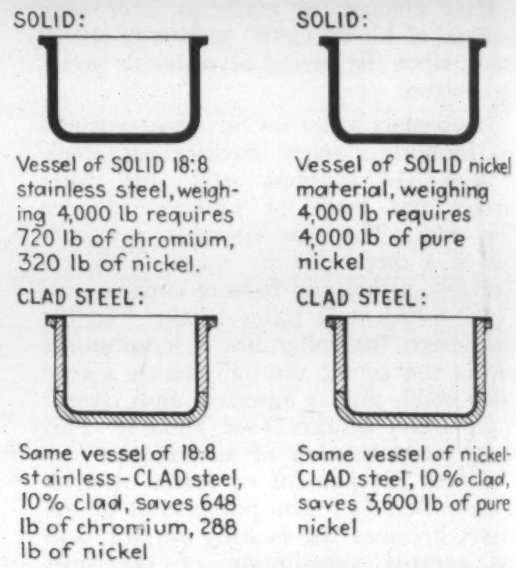
In some tube applications, such as close spaced rectifiers, nickel clad steels, consisting of approximately 10% of nickel on each side of a low carbon steel, replace solid nickel and thus permit nickel savings of 80%. In such uses the nickel clad steel is carbonized in the same manner as solid nickel.



*Steps in forming lamp fixture components out of copper-clad steel. (American Clad-metals Co.)*



*Hardfacing flanged Caterpillar rollers to save scarce metals. (Stoody Co.)*


SOLID:
Vessel of SOLID 18:8 stainless steel, weighing 4,000 lb requires 720 lb of chromium, 320 lb of nickel.
SOLID:
Vessel of SOLID nickel material, weighing 4,000 lb requires 4,000 lb of pure nickel
CLAD STEEL:
Same vessel of 18.8 stainless-CLAD steel, 10% clad, saves 648 lb of chromium, 288 lb of nickel
CLAD STEEL:
Same vessel of nickel-CLAD steel, 10% clad, saves 3,600 lb of pure nickel

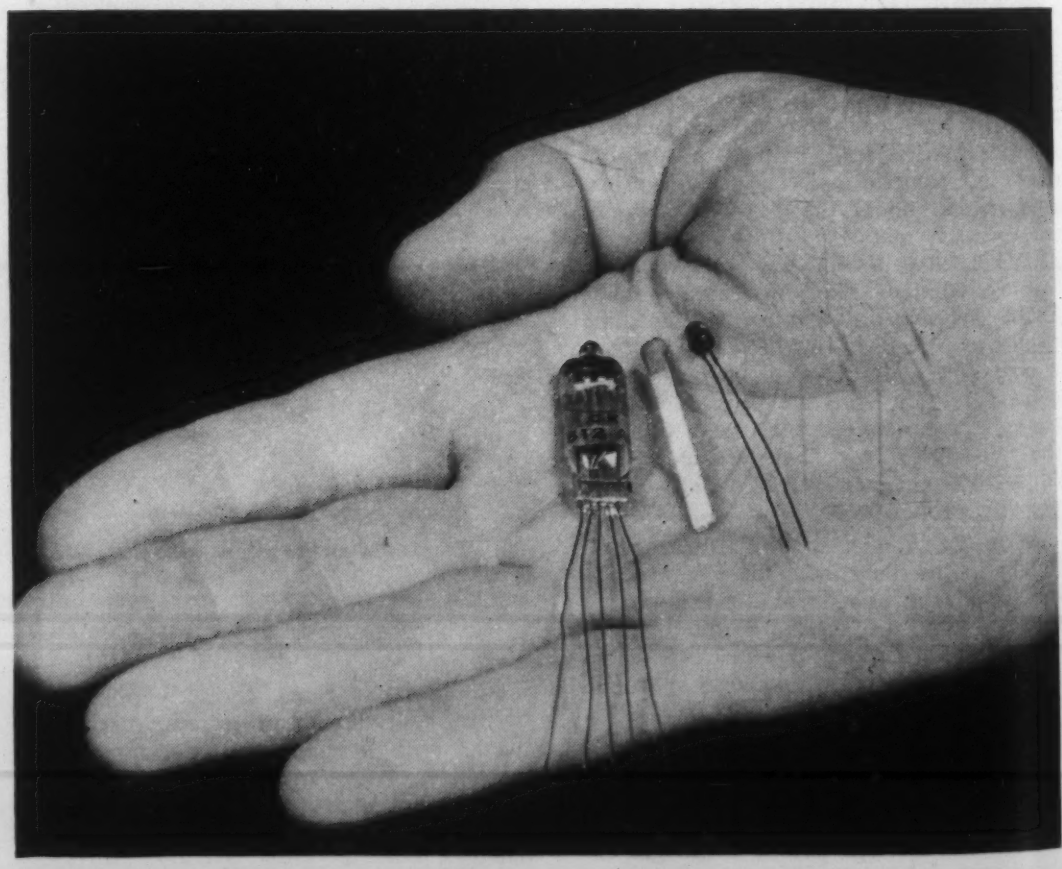
***Amount of strategic metals saved by using clad steel instead of solid metal. (Lukens Steel Co.)***

Finally, the accompanying sketch shows the savings of strategic nickel and chromium realized by adopting stainless clad steels in place of solid alloys for typical vessels.

## Hard Facing

Hard facing can be used in two ways to save scarce metals. It can be used in the original production of parts by providing a hard overlay on less critical carbon steel. In this use it functions similarly to clad metals. The other use of hard facing is to rebuild worn surfaces and thus avoid replacement of parts made of scarce materials.

Hard facings can be applied to parts for wear resistance, heat resistance, corrosion resistance, or any combination of these three. But most hard facing is done to improve wear resistance. Thus, it has been widely adopted for rebuilding worn surfaces in earth-working, processing



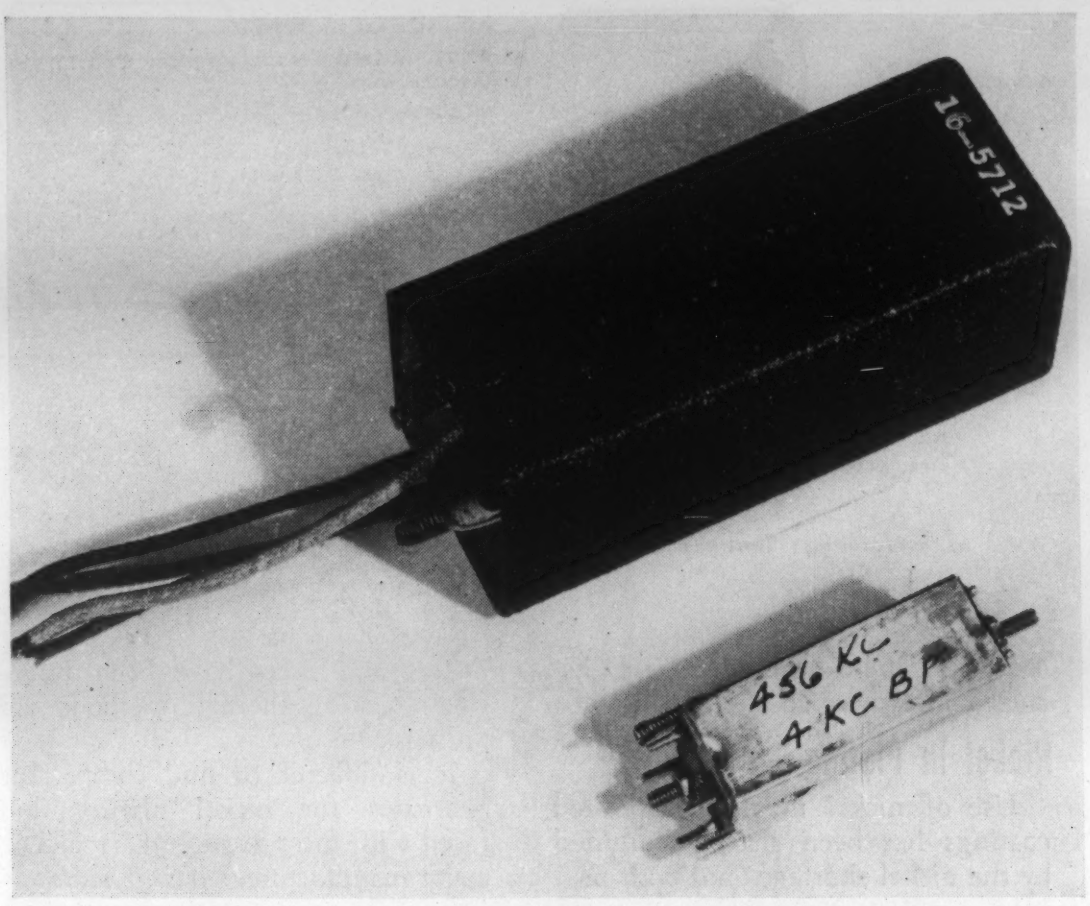
*Critically scarce materials were saved by replacing the radio tube at left with the crystal rectifier shown on the right. (U. S. Army photograph)*

and handling equipment. A common example of wearing parts now in short supply are tractor rollers; the destructive service to which they are subjected results in rapid wear and frequent replacement. However, by hard-facing the worn portions, these rollers can be reused, thus saving considerable material.

### Use Less per Item

Some ways of using less scarce material per item have already been touched on, *i.e.,* redesigning to another form, and use of composite materials. There are several other things that can be done. Scarce materials should be used very selectively. Ways should be studied to confine them to the portion of the part or product where they are indispensable, and the more plentiful materials adopted for less critical spots. Also, many products are over-engineered in normal times. In many cases section thicknesses can be reduced without impairing service life.

Another method that shows decided promise of saving materials, especially in the electronics field, is miniaturization. Reducing the size of components saves strategic materials as well as space and weight. In the production of high-frequency transformers for radio communication equipment, it is possible to make considerable reduction in size by use of iron powder cores. Even further reductions can be made by using ferrite cores. In one case the dimensions of a standard transformer were reduced from 1¼ by 1¼ by 3 in. high to ⅝ by ⅝ by 1⅝ in. high by adopting iron powder cores. In another case a sub-miniature radio tube was designed so small that it would take 67 of them to equal in size one conventional tube.




***Good grade iron powder cores made possible the miniaturization of this standard i-f transformer. (Metal Powder Assn.)***

# The Scarce Materials—How to Conserve or Replace Them

## Nickel

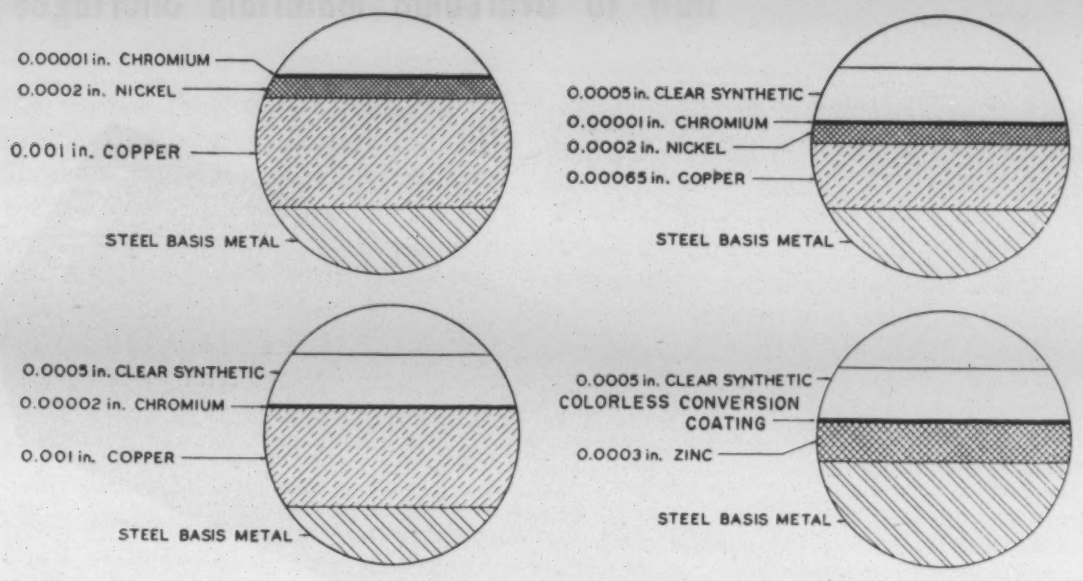
Nickel, one of the scarcest of the scarce engineering materials, has three major fields of use:

1. Upwards to 50% of the total nickel is used as an alloying element in irons and steels in normal times. For ways to conserve nickel when used as an alloying element, refer to the sections that follow on alloy steels and heat and corrosion resistant steels and irons.
2. From 10 to 15% of the total nickel is used for plating in normal times. The next section will deal with the various ways to save or replace nickel for plating.
3. About 30% of the total is used in its commercially pure form or in high nickel alloys such as monel, Inconel and the special purpose grades.

There is very little that can be done about stretching the available supply of high nickel alloys. Since there are relatively few different alloys, there is not much chance of switching from one alloy to another and still obtain essentially the same properties. Nor is down-grading a feasible solution; for example, to down-grade monel from 70 nickel, 30% copper to, say, 50 nickel, 50% copper would mean using more copper, which is as scarce as nickel. In some cases it might be possible to use a low carbon Armco iron as a diluent, but here again this type of iron is hard to get. And anyway, down-graded nickel alloys are not being produced commercially at this time.

There are, however, several possible alternates for nickel alloys that are worth considering. Nickel or nickel alloy clad steels is one, and further details are given in the discussion of clad metals. Another possibility is the substitution of stainless steels, which, although also scarce, have considerably smaller nickel contents. For example, in some applications, where temperatures below 1600 F are involved, the 18:8 stainless types can be substituted for Inconel. For temperatures above 1600 F, types 309, 310 or 330 should be considered. Although these substitutes will not have as long a service life as nickel alloys, they will serve satisfactorily as a stop-gap material in many instances.

Other possible alternates for nickel alloys include porcelain enameled steel, glass, and corrosion resistant




***Ways of overcoming shortages of nickel in chromium plating. (From the "Unichrome Observer")***

coatings. These and others are discussed elsewhere in the article.

## Nickel in Plating

Use of nickel in electrodeposited coatings has been sharply curtailed by the nickel shortage, and both producers and users have been intensively seeking alternate methods and finishes.

It is difficult to find comparable alternates for nickel plating, but faced with the prospect of no nickel, many manufacturers have tried various replacements and found them to be quite satisfactory, although not as good as nickel. In other cases, they have found them at least equal to nickel.

Below are given a number of ways of either reducing the amount of nickel used, or substituting other coating systems.

*Less Nickel, More Copper*—A common specification for chromium plated steel parts for outdoors use is 0.00065-in. copper, 0.0006-in. nickel, and 0.00001-in. chromium. Some engineers, believing that copper and nickel provide about equal protection to steel, specify the combined thickness of copper and nickel. The sketch shows the nickel layer reduced to 0.0002 in. and the copper layer increased to 0.001 in.

*Less Nickel Plus Clear Synthetic*—Another method is to reduce the nickel to 0.0002 in., keep the conventional copper and chromium

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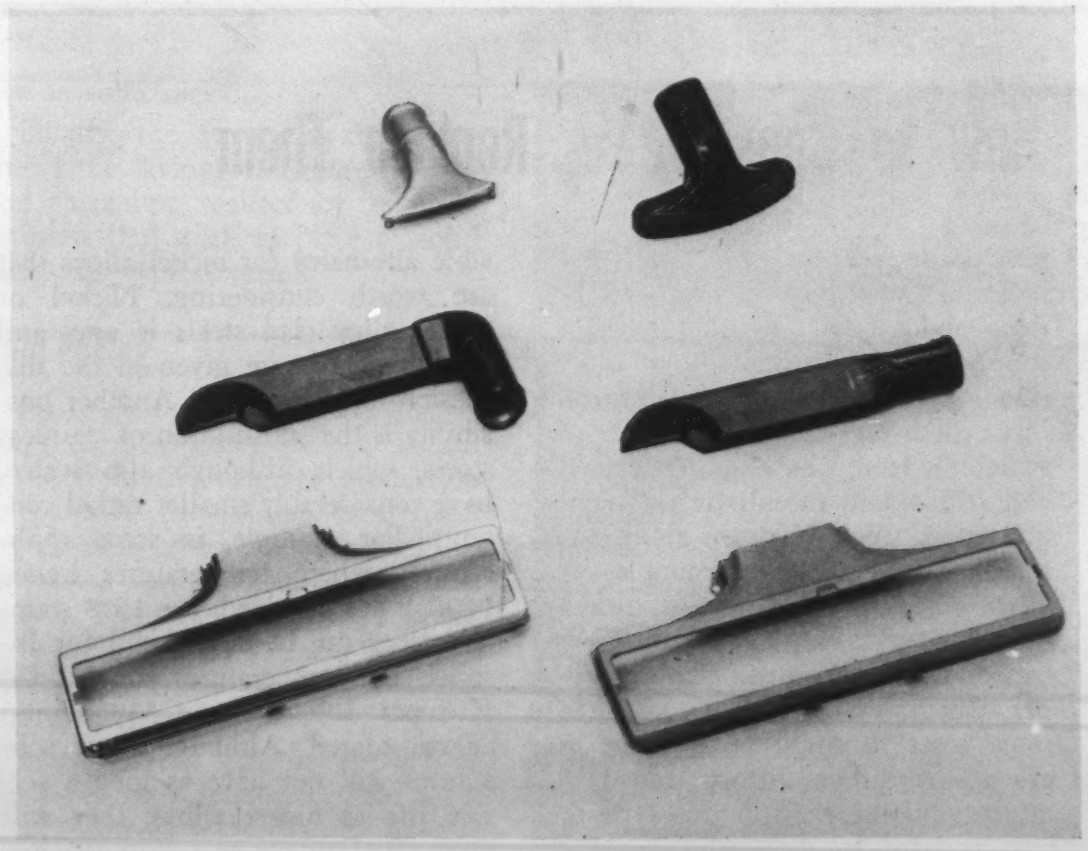
# Normal Procedure of Tooling for Several Alternate Materials Eases Material Shortages at Hoover

The normal procedure at the Hoover Co., manufacturers of vacuum cleaners, is to have tooling available for several different materials—steel, aluminum and plastics—in order to constantly study these three materials and pick the best. Thus, when aluminum came under control, it was comparatively easy to switch to steel.



***Some changes made by Hoover Co. to save critical materials. Top: aluminum die cast brush holder (left) replaced by a Bakelite molding (right). Center: aluminum die cast angle in converter has been eliminated, as shown at right. Bottom: nickel plated bottom plate and nozzle lip (left) now finished with baked enamel (right) on some models.***

Now that both aluminum and steel are controlled, plastics are being adopted more and more. A program is now underway to replace aluminum die castings with either phenolic thermosetting plastics or thermoplastics, such as acetates, etc., depending on the mechanical requirements of the parts. Even before the present rubber shortage, a study was started to replace rubber by vinyl plastics because they perform as well as rubber and have a better appearance.

Here are a few specific examples of replacements already made:

Steel replaces aluminum for extension tubes and for the converter used to attach the cleaning tools. Total saving is 0.726 lb of aluminum per cleaner.

Plastics replace aluminum in floor and dusting brush in one model. Total saving is 0.633 lb of aluminum per cleaner.

Steel replaces aluminum for a number of small parts such as washers, fan spacer, mounting rings and bag envelope supports.

A plastic-copper material (produced by a subsidiary in England) replaces a copper commutator.

All nonfunctional, nonelectrical uses of copper and copper alloys are being changed to steel.

Zinc castings are being eliminated first by changing to aluminum and later to plastics. Component parts are being interchanged on models to use those with the smallest zinc castings.

All cadmium plating is being replaced by zinc plating or enamel finishes. Zinc plating, itself, is being reduced by using enamels and other organic finishes. Some nickel-plated parts are now being finished in enamel.

thicknesses, and coat with a clear organic coating, such as nitrocellulose-acrylic lacquer or urea-formaldehyde baking enamels. In cases where clear synthetics were normally used with the conventional nickel plating, such as refrigerator shelves, the synthetic coating thickness has been increased to 0.001 in. to compensate for the decrease in nickel thickness.

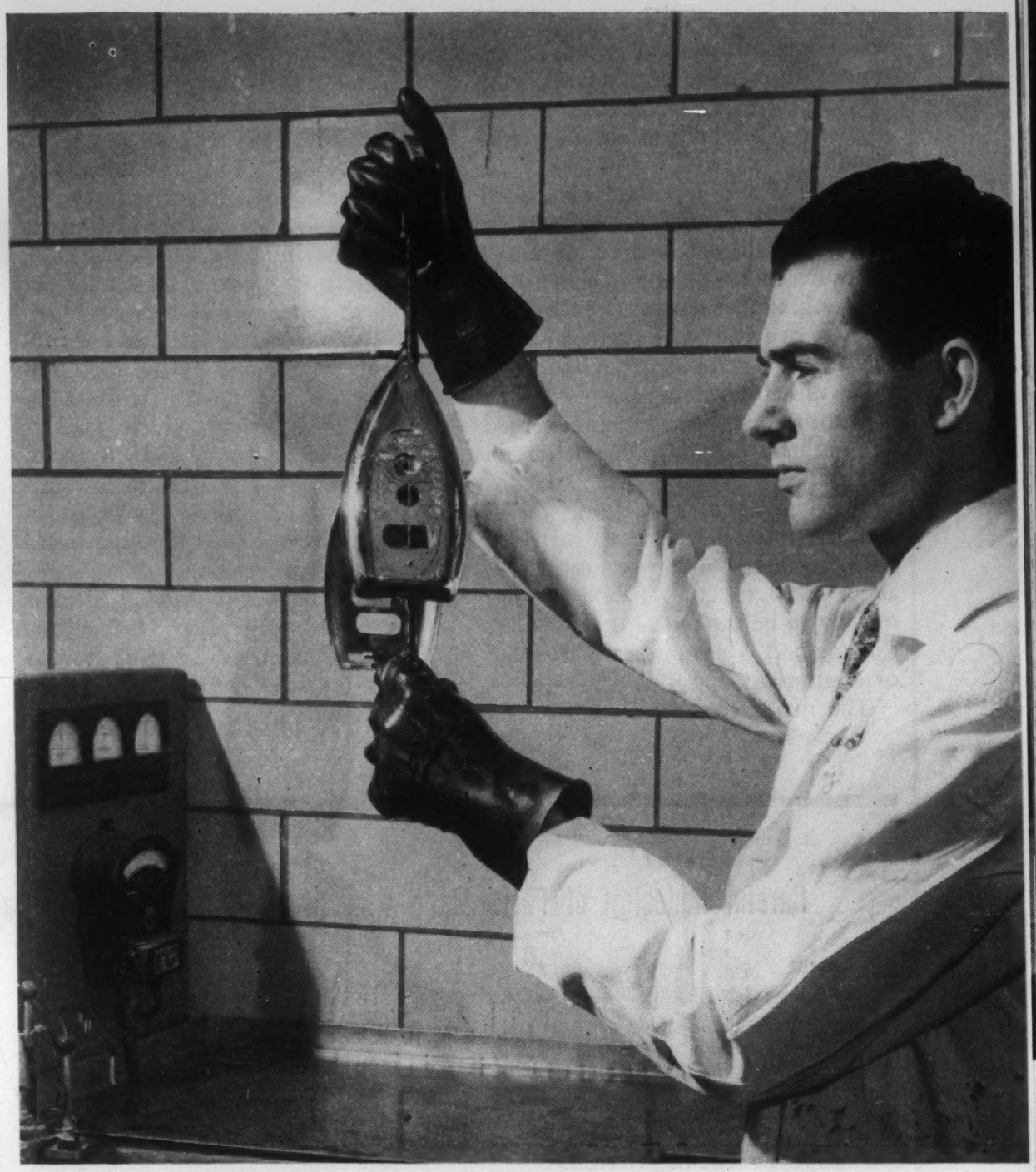
*Copper, Chromium and Synthetic*—For some applications nickel can be omitted entirely. The steel is plated with copper and chromium, then coated with a clear synthetic. The periodic reverse-current plating method can be used to advantage here, because it provides a high quality, smooth finish.

*Zinc and Bright Dip*—Another method of eliminating nickel is to zinc plate on the steel followed by a dip in chemical solution. The solution reacts with the zinc to form a transparent colorless coating. Although this system generally is lower in weather resistance, it is suitable for many indoor applications, or where exposure is not severe. To increase durability, a clear enamel or lacquer can be applied over the dip coating. Some business machine manufacturers have adopted this method to replace both nickel and cadmium plating.

*Zinc Plus Chromium*—A relatively new process under patent application permits electrodeposition of a decorative chromium plate directly over zinc plated steel parts or zinc die castings. The method essentially involves depositing 0.0003-in. thickness of zinc on the base metal, followed by a bright dip; then followed by chromium plating.

*Other Methods*—Platers are adopting other methods to conserve nickel. Only functional parts are being plated; dragout of solution is kept to a minimum; excessive deposit build-up at high current density areas is avoided by racking work to produce more uniform deposit thickness.

Synthetic enamels have been developed that resemble a chromium finish, and where a chromium plate effect is the major requirement, they can often be used. One producer reports that organic finishes of this type are being used on hardware, lamps, metal furniture, and bathroom fixtures.



*Periodic reverse-current plating provides a bright chromium-copper finish, where nickel cannot be used. (Westinghouse Electric Corp.)*

## Corrosion and Heat Resistant Steels and Irons

Since many stainless steels contain highly critical columbium and nickel, they were one of the first groups of materials to come under restrictive orders. Thus, the problem of selecting alternates is largely one of finding alloys of comparable properties which do not contain columbium or nickel.

Columbium is used in the welding grades of stainless steel as a stabilizer to prevent the precipitation of brittle carbides in the welded joint. There are two broad alternatives: (1) choose a type stabilized with titanium; or (2) choose a grade in which the carbon is adjusted so that stabilization is not necessary.

Type 347 stainless, which is stabilized with columbium, can usually be replaced by types 430 or 321, which are stabilized with titanium. Titanium is considered by some experts to be a better stabilizer than columbium. Columbium is added in the proportion of about ten parts to one of carbon, whereas titanium is added in the proportion of only five parts to one of carbon.

The second method—that of adjusting carbon content—usually means picking a grade in which carbon is held to a maximum of 0.03% so that carbides cannot form and precipitate. At 0.03% carbon, there is maximum improvement in preventing carbide precipitation. Work by a leading producer of stainless steels showed that a difference in carbide precipitation between steels of 0.07 and 0.05% carbon is negligible.

Where service requires a molybdenum-bearing grade of stainless, and type 318 would normally be chosen, type 316, having a similar composition but containing no columbium, can be used. In this type,

carbide precipitation is controlled by using low carbon. The molybdenum grades are usually selected for their special corrosion resistance, or for high creep strength at elevated temperatures.

There is one important caution in the use of low carbon stainless steels. Service should not involve continued exposure to temperatures above 800 F. Long time exposure to temperatures above this will result in slow but definite carbide precipitation in these unstabilized grades.

Another method sometimes used to eliminate carbide precipitation in unstabilized grades is the use of heat treatment after welding to redissolve the precipitated carbides. The treatment involves heating to about 1950 to 2050 F and cooling quickly to below red heat. However, this method is not always practicable or economical.

The major consideration involved in selecting alternates for nickel bearing types of stainless steel is obtaining satisfactory corrosion resistance without too great loss of workability. Higher alloy content causes a rapid loss in workability, and lower alloy content reduces corrosion resistance. Thus, such types as 410, having only 12% chromium, are rarely satisfactory substitutes for 18:8 or other nickel bearing types.

Of the grades of stainless not containing nickel, one of the most important is type 430, with 17% chromium, which is widely used as a replacement for the 18:8 types. When produced with extra low carbon, the workability, especially in deep drawing and spinning, seems to show improvement.

Where type 430 stainless steel is to be used to replace 18:8 alloys, the replacement will be most successful if (1) the corrosive conditions are not too severe; (2) the alloy is frequently cleaned in service; (3) fabricating requirements are not too severe.

Type 430 does not have the corrosion resistance of the 18:8 compositions, and is probably not a satisfactory replacement for many uses in hospital equipment, in the chemical industry, in breweries, and in dairies. Its oxidation resistance is good, and it is suitable for most uses in furnaces, etc. Decorative applications, and such uses as cookware, sinks, counter tops and ice cream cabinets, where the piece is cleaned frequently, can use the 430 material successfully. Where longtime immersion in liquids is a condition of service, there may be some superficial corrosion. Its weldability is limited by its tendency to embrittlement because of grain growth, and drawability is rather poor owing to the lowered ductility of the material. Modifying practice to suit the ma-

## Careful Redesign of Parts Made with Alternate Materials Maintains Quality of IBM Products

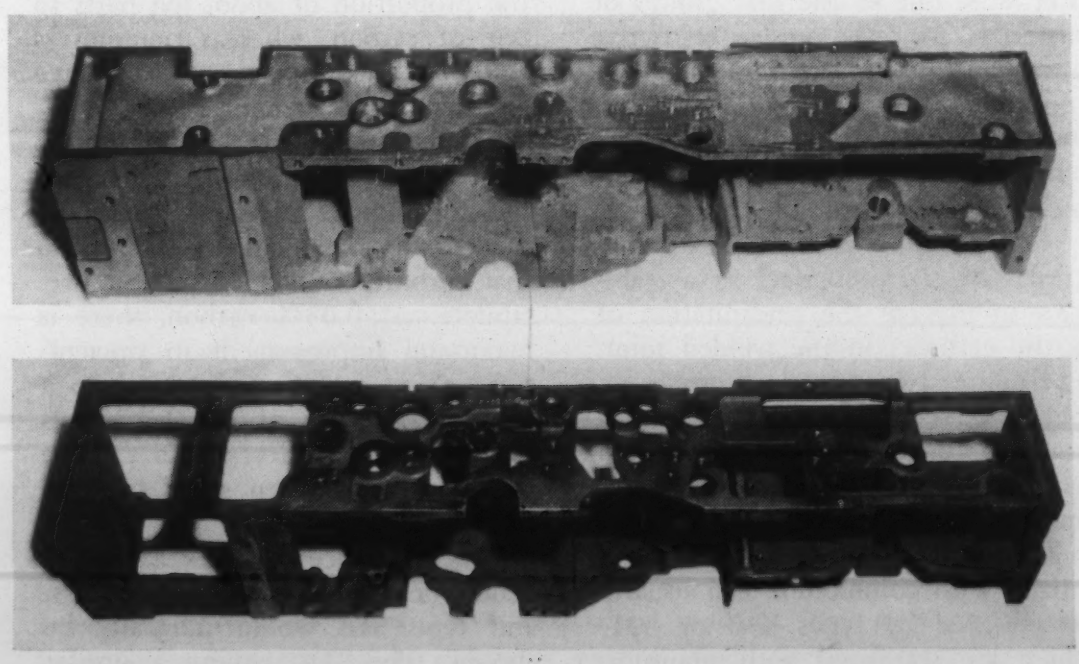
Aluminum alloys in the form of die castings, permanent mold castings and extrusions are widely used in a number of the business machines produced by International Business Machines Corp. To overcome the prevailing aluminum shortages without sacrificing quality, they are undertaking the following changes:

(1) Replacing aluminum castings with magnesium die castings and gray iron castings. Examples: top cover and front case section of typewriter, formerly aluminum die castings, will be magnesium die castings; card punching machine base, formerly a permanent mold casting, will be a gray iron casting.

(2) Replacing aluminum castings with formed and fabricated steel parts. Example: type basket of typewriter, formerly an aluminum die casting, will be a steel assembly made by stamping, forming and fabricating.

(3) Replacing aluminum extrusions with plastic extrusions wherever plastics are available. Example: machine trim.

A relatively large machine base casting for a card punching machine, formerly made of an aluminum-magnesium alloy (Almag 35, containing about 7% magnesium), is being successfully replaced by a gray iron casting. The aluminum-magnesium alloy was originally used because of its light weight, high resistance to atmospheric corrosion, and good machinability. To retain these properties in the gray cast iron part, the following changes are required: To provide the necessary corrosion resistance, the gray iron casting will be coated with a wrinkle finish, except for the card bed surface, which will receive a clear baked lacquer. To assure good machinability, the casting will be annealed. And to provide light weight, holes have been located wherever possible in the walls.



*This gray iron casting (bottom) for a business machine base replaced an aluminum-magnesium alloy casting at IBM.*

Other changes which are planned or underway at IBM to overcome critical material shortages include:

1. Substituting 40 tin-60% lead solder for the conventional 60 tin-40% lead type. The higher melting point (450 F) of the substitute makes it more difficult to use, and in some applications precautions must be taken to prevent a loss of hardness in the joined parts.
2. Replacing porous bronze with porous iron powder for bearings.
3. Changing from beryllium copper and phosphor bronze to AISI 1070 spring steel for flat springs. The 1070 springs require an extra surface treatment of black oxide plus a coating of oil or wax to prevent rusting.
4. Switching from the high nickel containing alloys, such as 80 nickel-20% chromium, for heat treating fixtures to lower nickel alloys or chromium-plated steel.

terial should make it a satisfactory substitute where these fabricating methods are involved.

Of course, chromium is on the scarce list also, and what has been said above is only good as long as chromium grades can be obtained. When the chromium grades in the 400 series are unsatisfactory or unavailable, there are still several other possibilities open. These include:

1. Use of low carbon steel with corrosion resistant coatings. Among the possible types of coatings are glass or ceramic coatings, conversion concretes, and various types of refractories.
2. Use of clad steels.
3. As a last resort, use of plain carbon steel. This can be done only where there is no pitting type of corrosion and where section thickness can be increased to compensate for the corrosion that will take place.

Since the shortage of stainless steels began, more and more emphasis is being placed on the new light-walled Schedule 5 stainless steel pipe. Compared with heavier pipe, such as the well-known Schedule 40, this pipe provides two or three times the pipe footage per pound of stainless steel. From the strength standpoint, Schedule 5 stainless pipe is satisfactory for the vast majority of applications, being able to withstand working pressures up to 150 psi.

Silicon carbide refractory material can serve as an alternate in many industrial high temperature applications. Radiant tubes and roller hearths in heat treating furnaces have been made successfully with silicon carbide. This material has the characteristic of increasing in strength and rigidity up to about 2500 F.

Where elevated temperatures are the major consideration, carbon steels can be used in many cases up to around 825 F. From around 800 too 1050 F, the ferritic grades, such as types 430 and 446, should be considered if available. For severe service conditions above about 1050 F, 18:8 stainless types are required. Although columbium stabilized 18:8 grades have been used, the more plentiful titanium is being adopted increasingly as a stabilizing agent.

In respect to nickel and chromium containing alloy castings, downgraded compositions must be used wherever possible, even though shorter service life may result. For example, by sacrificing some service life, many parts formerly made of a 65 nickel-15% chromium iron alloy can be changed to a 35 nickel-15% chromium composition.

## Alloy Steels

Since the present shortages began the steel industry has been actively engaged in developing alternate steels containing a minimum of critical elements to replace the so-called SAE type constructional alloy steels. During World War II the National Emergency (NE) steels were evolved; since then many of them have become standard and are again being adopted. The NE steels were devised on the well-known principle that if two elements are equally effective, a greater hardenability will be obtained by using one-half as much of each of them.

The standard NE steels that are now being used widely as alternates for higher alloyed steels are the nickel-chromium-molybdenum steels of the following series: 86XX, 87XX, 93XX, 94XX, 97XX and 98XX. Since June, 1950 the use of these steels has increased from 16 to 24% of the total alloy ingots produced. The accompanying table lists the standard steel series and the NE type steels that can be used as alternates for them.

Much experience has been gained in using these steels so that little trouble should be encountered in adopting them. In heat treating it is important to remember that temperature must be held within about 100 F as compared to about 200 F for high nickel alloys.

On Feb. 1, 1951 the American Iron and Steel Institute introduced the boron steels, which are designed to conserve manganese, nickel, chromium and molybdenum. These steels are still in the early stages of production, but should rapidly find wide use as alternates for the critically scarce alloy steels. During the last war it was found that very small additions of boron considerably enhanced the hardenability of certain steels. It is on this basis that the boron steels have been developed.

Thus far, four series of boron steels have been introduced commercially. The new steels are balanced multiple alloy steels designed to make maximum use of the alloys contained in scrap. They have 0.0005% minimum boron content and a maximum of about 0.003%, plus small amounts of manganese, nickel, chromium, molybdenum and silicon. In general, they contain only

**Standard Alternates for Alloy Steels**

| Standard Steel Series | Standard Alternates (NE Type) |
|---|---|
| 1300 | 8600 |
| 2300 | 8600 (to 2330 inclusive) |
| | 8700 |
| | 8600 plus 5 points carbon (for 2335 and higher) |
| | NOTE: For low temperature applications, consider the possibility of using a heat treated product. |
| 2500 | 9300 (except for low temperature and corrosive condition applications) |
| 3100 | 8600 (to 3130 inclusive) |
| | 8700 |
| | 8600 plus 5 points carbon (for 3135 and higher) |
| 3300 | 9300 |
| 4000 | 9700 |
| 4100 | 8600 (to 4130 inclusive) |
| | 8700 plus 5 points carbon (for 4132 and higher) |
| 4300 | No generally applicable alternate |
| 4600 | 8600 (for bearings RBEC 4700 may be necessary) |
| 4800 | No generally applicable alternate |
| 5000 | Special low alloy |
| 5100 | 8600 |
| 52100 | No generally applicable alternate |
| 6100 | 8600 |
| 8600 | No change |
| 8700 | No change |
| 9200 | 8600 |
| 9300 | No change |
| 9400 | 8600 |
| 9700 | No change |
| 9800 | No change |

## Boron Steels

| Grade | Chemical Composition Limits, % | | | | | | Hardenability Equivalent To: |
|---|---|---|---|---|---|---|---|
| | C | Mn | Si | Ni | Cr | Mo | |
| 80B15 | 0.12–0.18 | 0.60–0.90 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8615 |
| 80B17 | 0.14–0.20 | 0.60–0.90 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8617 |
| 80B20* | 0.17–0.23 | 0.60–0.90 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8620 |
| 80B25* | 0.21–0.28 | 0.60–0.90 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8625 |
| 80B30 | 0.27–0.34 | 0.55–0.80 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8630 |
| 80B35 | 0.32–0.39 | 0.65–0.95 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8635 |
| 80B40 | 0.37–0.45 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8640 |
| 80B45 | 0.42–0.50 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.15–0.35 | 0.08–0.15 | 8645 |
| 80B50 | 0.47–0.55 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.25–0.50 | 0.08–0.15 | 8650 |
| 80B55 | 0.50–0.60 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.30–0.55 | 0.08–0.15 | 8655 |
| 80B60 | 0.55–0.65 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.30–0.55 | 0.08–0.15 | 8660 |
| 81B35 | 0.32–0.39 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.30–0.55 | 0.08–0.15 | 4135 |
| 81B40 | 0.37–0.45 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.30–0.55 | 0.08–0.15 | 4140 |
| 81B45 | 0.42–0.50 | 0.70–1.00 | 0.20–0.35 | 0.20–0.40 | 0.30–0.55 | 0.08–0.15 | 4145 |
| 81B50 | 0.47–0.55 | 0.75–1.05 | 0.20–0.35 | 0.20–0.40 | 0.35–0.60 | 0.08–0.15 | 4150 |
| TS 86B45 | 0.43–0.48 | 0.75–1.00 | 0.20–0.35 | 0.40–0.70 | 0.55–0.75 | 0.08–0.15 | 4340 |
| TS 94B17 | 0.15–0.20 | 0.75–1.00 | 0.20–0.35 | 0.30–0.60 | 0.30–0.50 | 0.08–0.15 | 4817 |
| TS 94B20 | 0.17–0.22 | 0.75–1.00 | 0.20–0.35 | 0.30–0.60 | 0.30–0.50 | 0.08–0.15 | 4820 |

about one-half the amount of critical elements present in the NE type steels. The accompanying table gives the compositions of the new boron steels and lists the standard steel series having equivalent hardenability.

For ordinary engineering uses, the boron steels have essentially the same properties as the standard steels of equivalent hardenability. In general, the heat treatment is the same. However, care must be taken not to overheat these steels, because holding too long at temperature will result in the boron losing its hardening effect. They should be quenched from a temperature about 75 F higher than the corresponding standard steel, and they should be tempered at as low a temperature as possible.

The boron steels have not yet been out in commercial use long enough to be given full scale tests on what they can and cannot do. However, results of a few applications have been reported. In one case a 10B45 boron steel was used in place of SAE 9445 for forged open end wrenches, and the result was that 25% greater life of the forging dies was obtained, and 30% less cleaning was required. In another application, 10B35 boron steel replaced 8640 steel for cold headed bolts and cap screws. In this case there was a 35% decrease in tool and die maintenance.

Three other new groups of steel were officially announced last March. One of these groups, designated TS86XX, was made available to replace standard lean 86XX nickel-chromium-molybdenum steels. Their composition is very close to the standard 86XX except that the molybdenum content is somewhat lower (0.08 to 0.15%), and the chromium content somewhat higher (0.55 to 0.75%). These steels are satisfactory for light sections, but standard 86XX should still be used on heavy sections.

Another new series, TS81XX, is similar to the TS86XX series, except that they have higher nickel (0.20 to 0.40%) and lower chromium (0.30 to 0.50%) content. A third new group of steels, designated 4137 INT, were made available to be used in place of the 4100 steels and to save molybdenum.

The final step in finding substitutes for the alloy steels is to try carbon steel plus proper heat treatment to get the desired properties. This solution is likely to be found feasible in a surprisingly large number of applications. The ingenuity in changing designs or fabricating methods in order to employ high carbon steels in place of alloy steels has by no means been exhausted. High carbon steels lend themselves to selective area or selective surface heat treatments, and this can be exploited in many cases. In other applications increasing section thickness might provide the answer.

## Copper

Ways of overcoming copper and copper alloy shortages are limited. Perhaps the most natural steps are (1) switch from copper or high copper alloys to low brasses where either will serve, (2) switch to another material, (3) redesign to use less copper per item. The first step is not easy to accomplish, since zinc is also in short supply. The second and third methods offer possibilities, although in many cases it means some sacrifice in quality or in service life.

Aluminum is the only practical alternate for copper for electrical applications. But its present scarcity limits its use. Replacing copper with aluminum raises other problems, too. For a given cross-section, aluminum has about 61% of the conductivity of copper. Thus, to have the same conductivity, an aluminum part must be about 1.5 times larger in dimensions than a copper part. This becomes a problem when considering aluminum for rotating machines, transformers, and other devices.

Where copper is used for nonmagnetic or corrosion resistant purposes, the problems are not as serious as when electrical conductivity is involved. Coated steels and irons, and nonmetallics will have to be used in place of copper in many applications. Again, as in World War II, a shift from brass to steel cartridge cases is underway. Army Ordnance is seriously considering the adoption of iron powder rotating bands in place of gilding metal ones. Solid bronze bearings are being replaced by steel backed bearings. Printed circuits are being used in place of copper wiring in the electrical and electronic fields. Steel and iron hardware are replac-

ing solid brass designs; in some cases a combination of steel and brass is used.

The third method—that of using less copper per item—offers a number of possibilities. The gage size or length of wire can be reduced. For example, lead-in wires on lamps can be decreased in length and diameter, or copper plated steel can be used instead of solid copper. Copper clad steel can be used in place of solid copper, as illustrated elsewhere in the article.

## Aluminum

The obvious alternates or substitutes for aluminum are the metals that originally were replaced by aluminum. However, some of these metals—copper alloys and alloy steels, among others—are themselves scarce and cannot be considered as alternates. Magnesium, which is not yet under controls or restricted in use, is perhaps the most promising replacement material. Many of its characteristics and properties are similar to aluminum, and it can replace aluminum in many indoor applications without too much difficulty.

Besides magnesium, steel, cast iron and nonmetallics such as plas-

## Materials Requirements Reappraised Early at Lewyt to Prepare for Shortages

The Lewyt Corp. did not wait for materials shortages to hit them before searching for alternates. When it became apparent that shortages were in the offing, the engineering department went over their vacuum cleaner part by part and determined just what other materials could possibly be used if their present materials became unavailable. The parts were then redesigned to make best use of the new materials and the tools ordered. For many parts they are now tooled up for two different materials, and in some cases three. Thus, they are able to switch from one material to another and back again, depending on the supply situation.

In many cases their investigations showed that the replacement material would be superior to the one now used. And in all cases, there is no sacrifice in service performance by adoption of alternate materials.

The accompanying photograph shows a number of the cleaner components in which materials changes have been made to overcome shortage problems. The air diffuser was formerly an aluminum die casting. It has now been replaced by a cellulose acetate molded part finished with a sprayed-on fine grain aluminum lacquer. Because of its excellent performance, it will be retained permanently. No major design changes were required. At first there was some concern over the possibility of shrinkage of the part in use, since it can reach 130 F and be subjected to heating and cooling cycles. The difficulty was overcome by allowing for the shrinkage in the design, and no trouble has been encountered.

The top handle, formerly an aluminum die casting, has also been redesigned for cellulose acetate. In order to provide added strength and a strong anchor for the self tapping screws by which it is attached to the cleaner, a flat carbon steel insert is molded in the handle. This alternate design will probably become standard since the plastic handle has a better "feel" and insulates against heat better than aluminum.

The air inlet baffle, originally an aluminum drawn shape, is now molded of cellulose acetate containing a small amount of aluminum powder to give a metallic appearance. The alternate has proved to be lower in cost and deadens the sound of the incoming air more effectively than aluminum. The part is also more easily produced by molding. When produced as an aluminum drawn shape, the hole (see photograph) had to be cut out; also, forming the flange, which has a compound curve, was a difficult operation.

The carpet nozzle has been redesigned from a two-piece assembly consisting of an aluminum die cast body and vinyl plastic lip to a one-piece cellulose acetate molding.

The brush control indicator, formerly a zinc-base die casting, is now a cellulose acetate molding with a steel ring insert located where the wear occurs.

All stainless steel parts, such as the carpet tool glider plate and the dust bowl latches, have been changed from type 302 (18:8) to 430 chromium type stainless. For this change it was necessary to redesign the tools and the parts to provide somewhat larger radii since type 430 does not have as good formability characteristics as 18:8 types. Some spot welding is done on these parts, but no difficulties from carbide precipitation have been encountered.

All rubber parts, such as dusting brush holder, dust bowl gasket, strain relief grommet, and attachment plug have been tooled for vinyl plastics. However, the cost is greater and, therefore, the switch to vinyls will not be made until they no longer can get rubber.

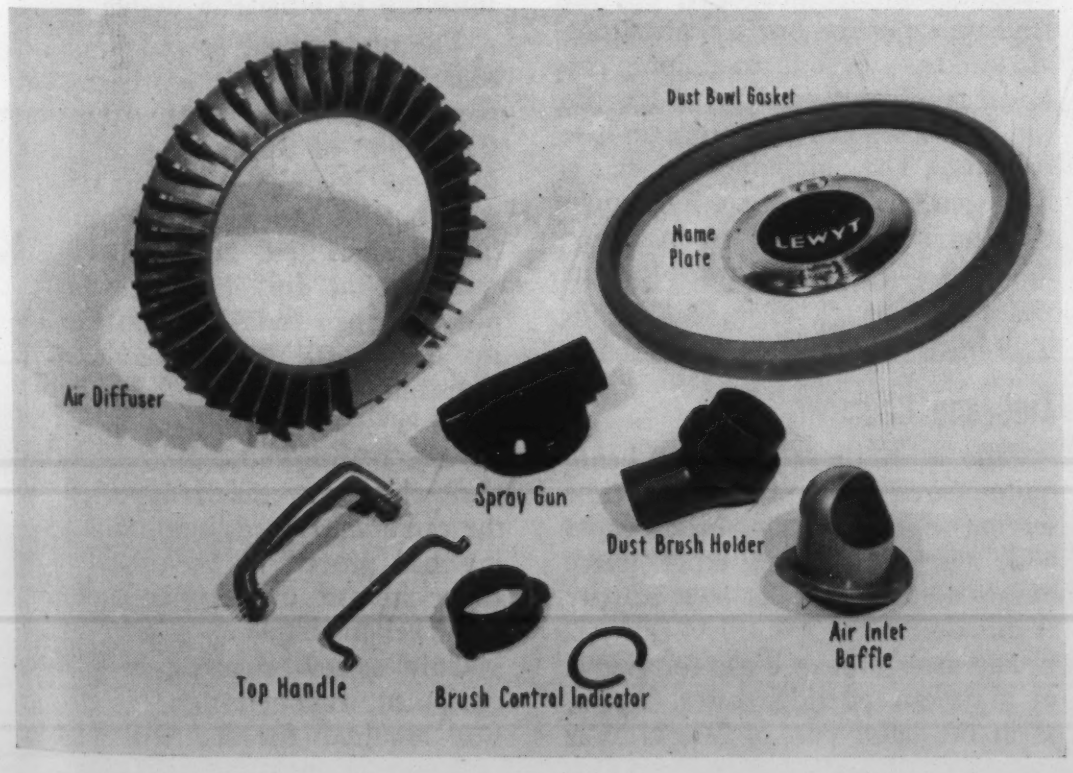
All of the outside housing parts of the cleaner body have been tooled for fiberglass reinforced polyesters, which are better than steel for these parts. They are considerably lighter in weight, stronger, and less susceptible to damage by denting. These are important features in a portable vacuum cleaner. However, fiberglas-reinforced plastics are more costly than steel and will not be used until shortages require them to do so.

The spray gun body is now made of an aluminum die casting, and because of its superior features, company engineers are reluctant to make any changes. Phenolics are lighter to use, but also are more susceptible to breakage, and will be resorted to only if necessary.

The name plate is normally a polished and painted aluminum stamping. This will be changed to a clear styrene or cellulose acetate molding and will be metallized on the underside to give the appearance of highly polished chromium plate.

Most of the brass stampings, and beryllium copper and phosphor bronze springs that go into the cleaner have been changed to steel.

***A few of the parts for the Lewyt cleaner which are now tooled for alternate materials.***



tics, wood, glass and ceramics should be considered as possible alternates. For example, formed sheet steel with an enamel coating can be substituted for aluminum in cooking utensils. Aluminum foil in many of its uses can be replaced by oiled paper, glassine, leadfoil or cellophane, although these alternates may not be as satisfactory as aluminum foil. Bottle caps, formerly aluminum, can be made of paper or painted steel. Many other examples of how scarce aluminum alloys have been replaced by more plentiful materials are given in the case histories and tables included in this article.

Another approach to consider is whether an aluminum alloy of higher strength can be used so that the same strength can be obtained with thinner sections—for example, use of 3S in place of 2S. Such a change may not often be possible because the high strength alloys are even scarcer than the lower alloyed types. Where lighter gage sheet of a higher strength alloy is available, it can usually be substituted without change in the design of stamped or drawn parts. The use of thinner sections in cast parts, however, often requires a new design in order to incorporate reinforcing ribs.

Available supplies of aluminum sheet can often be made to go further by reducing scrap from blanking and forming operations. Sometimes minor design changes, or minor changes in layout, will permit a given sheet to be used more effectively. Careful salvage of aluminum scrap, especially in the foundry, will also help to make available aluminum go further.

Reduction of the amount of aluminum used as an alloying agent will conserve appreciable amounts of aluminum. For example, the aluminum content in zinc-base die castings can be reduced to as little as 1% in some cases.

## Tin

During the last war we learned many ways to get around the tin shortage, and most of them still apply. Thus, lead-base babbitts replaced tin-base babbitts; bronzes, such as silicon bronze, were used satisfactorily in place of tin bronzes; lead burning replaced wiping solder; and lead-silver solders substituted for tin solders, except for soldering black iron or bonderized stock.

We also learned how to get along with less tin for tin cans. Although no single metal coating can serve as an alternate for tin in cans, other coating systems have been satisfactorily adopted for certain uses. Lacquered bonderized steel has proved successful in certain uses. For some non-food containers, terne plate (20 tin, 80% lead) can be used in place of tin.

The American Can Co. has developed a non-food container made of black iron sheet stock with a protective coating of enamel, and with a plastic cement as the seam sealer. A sanitary can has also been developed which saves substantial amounts of tin through use of a new low-tin solder having 2% tin content instead of the usual 40%. However, thus far a completely satisfactory tinless sanitary can has not been found.

One method of stretching the available supply of tin is to use electroplating instead of hot dipping methods. This makes possible thinner tin coatings and requires only about one-fifth the tin needed otherwise. Another method is the proposal by the Weirton Steel Co. that tinplate be produced with different thicknesses of tin on each side, the thickest coating being placed on the inside of the can.

For collapsible tubes, lead with an organic lining in place of tin is suitable in many cases. Tin is being saved in the manufacture of photoflash lamps by reducing the diameter of the solder wire and by reducing the tin content in the solder. A new solder has also been recently introduced which saves tin by using silver. It is reported that the solder permits savings of 50% or more in the amount of tin normally contained in solder.

As mentioned earlier, lead-base babbitts can be substituted for the tin-base types for many applications. A lead-base babbitt containing colloidal graphite is available which also can be substituted for high tin-base babbitts. The graphite, which is homogeneously distributed throughout the metal, serves as an added lubricant and is said to provide bearing properties at least as good as high tin-base babbitts.

## Zinc and Cadmium

Zinc is in the position of being quite scarce and at the same time serving as an alternate. Probably its wide use in place of other scarce metals accounts for its own scarcity at this time.

The main ordnance use for zinc is in brass for cartridge cases. Again, as in the latter part of World War II, steel cartridge cases are beginning to be used in place of brass, and this will save tremendous quantities of zinc (as well as copper).

The major peace time use of zinc metal is for die castings. During the last war zinc die castings did an excellent job of substituting for other alloys that would normally have had to be fabricated by more laborious methods.

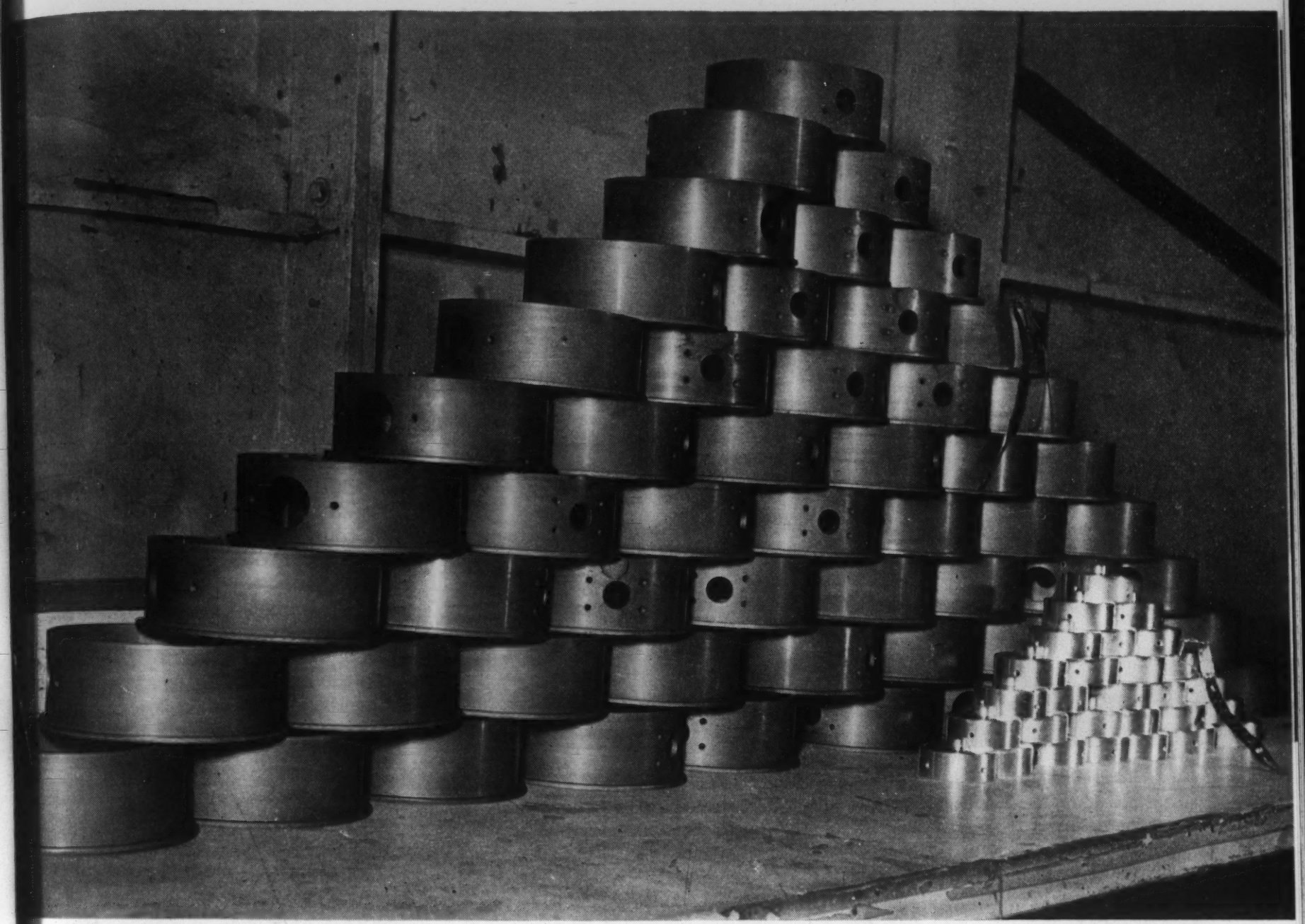
As for replacements for zinc die castings, aluminum, steel, cast iron and malleable iron castings can be adopted in some cases. In other cases, steel stampings are a possibility. And the available supply of zinc can sometimes be stretched by reducing the size of the casting. Where available, molded plastics are a possible alternate.

Zinc plating has widely replaced nickel and cadmium plating throughout industry. For example, at Glenn L. Martin Co., zinc plating is specified in place of cadmium plating for a major portion of their steel and copper parts. Among the exceptions are the following: parts subject to frequent sea water immersion or spray where tolerance requirements will not permit the use of 0.001-in. zinc plating; moving parts in which tolerances cannot be maintained in service with zinc plating; parts which in service reach 700 F; parts of electrical equipment soldered with noncorrosive (rosin type) fluxes; and certain parts of electronic equipment.

Business machine manufacturers are also adopting zinc plating. In one case, cadmium plating was formerly used on many of the interior steel parts. Many external parts were nickel plated and then lacquered after buffing, wire brushing or roll finishing to achieve a higher luster.

The replacement of cadmium and nickel plating by zinc has been completely satisfactory both from the standpoint of appearance and performance qualities based on test results obtained to date. After a 100-hr salt spray test, zinc plated parts (with bright dip) had a better appearance than cadmium. On humidity tests, little difference between zinc and cadmium has been noted. After a 2800-hr outdoor exposure the zinc plating showed no deterioration while gray stains appeared on the cadmium. In addition, zinc plating has proved to be considerably lower in cost than either cadmium or nickel plating.

Only a few changes in plating equipment were necessary. No change was required for the still plating



*Zinc plating is replacing cadmium plating at the Glenn L. Martin Co. plant for most parts. Photo shows a pile of zinc plated mechanical tubes (background), alongside a pile of plugs which have been plated with cadmium.*

procedures; however, for barrel plating, new tanks were required. Temperature control is more critical in zinc plating, and, therefore, tanks with heating and cooling coils were required. A chromic acid bright dip after plating replaced a nitric acid dip formerly used in cadmium plating. The purpose of the dip is to inhibit corrosion, whereas the nitric dip in cadmium plating was used to improve plate appearance.

As a replacement for galvanized steel, organic finishes or chemical surface treatments should be considered, such as phosphate coatings. In some applications a phosphate coating plus a wrinkle finish have proved very satisfactory.

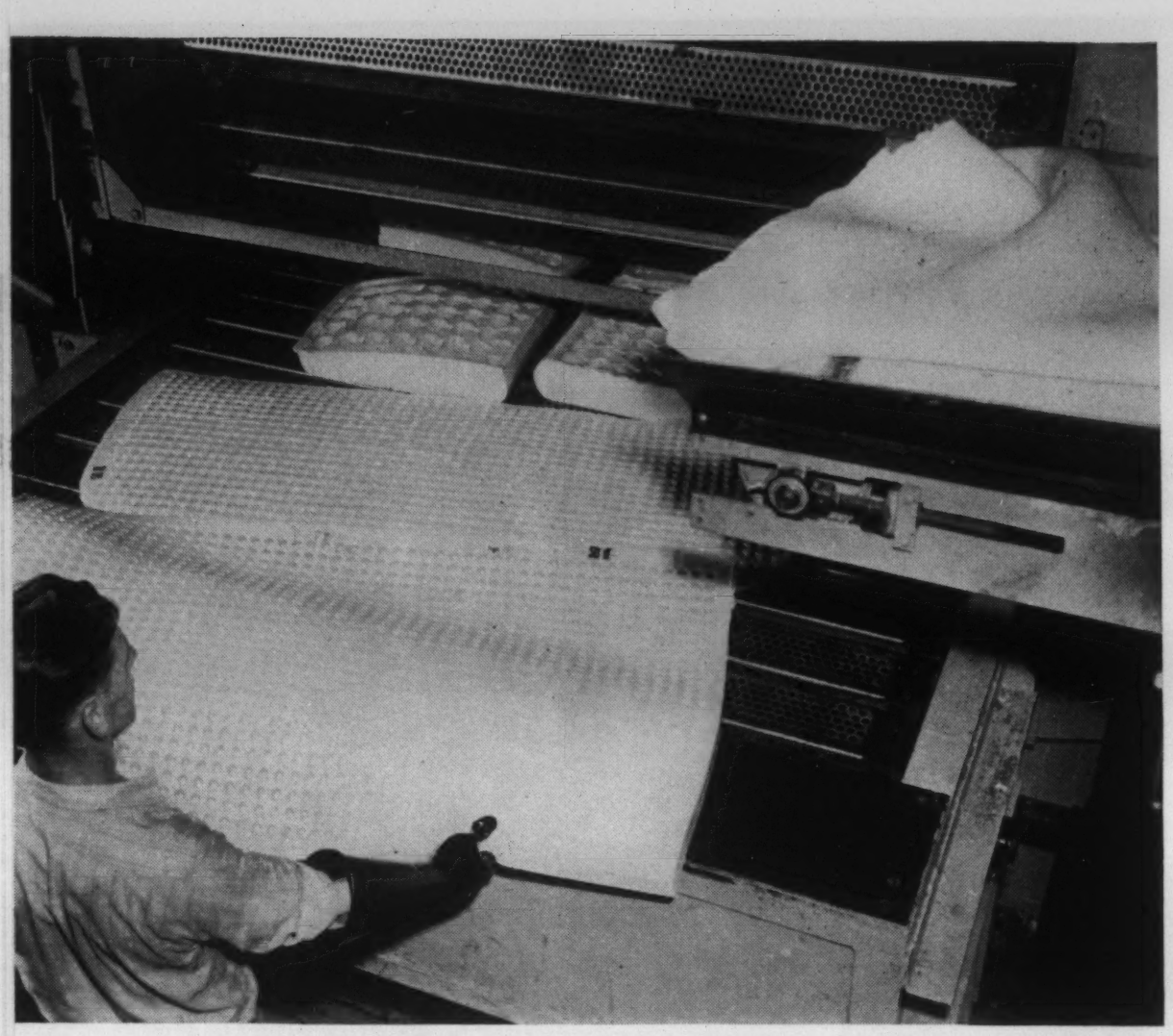
## Other Scarce Metals

*Cobalt*—Cobalt is one of our scarcest materials at present; it is in great demand for both magnetic materials and high temperature alloys. In recent years cobalt-free permanent magnet materials composed of superfine iron powder have been developed abroad which have properties comparable to Alnico magnets. It is believed that at least one electrical company in this country is beginning to make use of this material in some of its electronic devices.

Thus far, there is no known substitute for cobalt in the extremely high performance magnetic alloys. However, tungsten-chromium-molybdenum dispersion hardened alloys are alternates for the chromium-cobalt magnet steels. Nickel-aluminum alloys containing no cobalt, or up to around 5%, can be substituted for the chromium-16% cobalt alloys where no forging or machining is required. Various iron-nickel-aluminum alloys of the Mishima type might replace tungsten-cobalt steel types. And the use of electromagnets for permanent magnets wherever possible can help conserve cobalt.

In the heat resistant alloy field there are no substitutes for the cobalt-base alloys for temperatures above 1600 F, although combinations of ceramics and metals are being worked on. The only solution at present seems to be to keep operating temperatures below 1600 F and use high nickel-chromium alloys and stainless steels.

*Tungsten*—Tungsten is an alloying element in alloys for a variety of applications. It is used in high-speed tool steels, in high temperature alloys, and in permanent magnet materials. There are really no alternates for tungsten in these alloys. One large use of tungsten is for lamp filaments. Because of its scarcity many precautions are being taken to avoid wastage in the production of the filament wire. In some cases scrap tungsten is being reprocessed even though it is normally not economical to do so. What has been said about cobalt in respect to high temperature alloys also applies to tungsten.



*New cold synthetic latex can be used as a replacement for natural latex in the manufacture of foam cushioning for automobiles and mattresses. (U. S. Rubber Co.)*

*Columbium*—This scarce element has already been covered in our discussion of stainless steels. Besides being a stabilizer in stainless steels, columbium is normally used in welding electrode coatings; tantalum is substituting for columbium in this use. Also, a tantalum-columbium ferro alloy is being used as an alloying ingredient in some cases to replace regular columbium ferro alloy.

*Vanadium*—About 90% of the vanadium used in this country goes into steel as an alloying element. It is highly important in some tool steels, and much of it is reserved for this particular use. It is also an important ingredient in high temperature alloys. Since it is relatively more plentiful than molybdenum, it is being used in place of molybdenum in a number of alloy steels.

*Chromium*—Chromium has also been touched on in other parts of this article, and particularly in the discussion of heat and corrosion resistant alloys. There is no great shortage of chromium at the present, and it is, therefore, being relied on heavily as an alternate alloying element for other scarcer metals, such as nickel.

*Manganese*—Manganese is in a position somewhat comparable to chromium. Although in shorter supply than during World War II, it still is not extremely critical and is being used in place of more critical elements for alloying. However, in an all-out war, the supply would become exceedingly scarce. The possibility of using zirconium in place of manganese is now being considered.

*Molybdenum*—Molybdenum is exceedingly scarce, and there is practically none available for other than alloying purposes. As mentioned above, vanadium can be used in place of it as an alloying ingredient in a number of steels. Also, as discussed elsewhere, new alternate steels were introduced several months ago which contain considerably less molybdenum.

## Rubber

All rubber is short, but recently some rubber companies have hinted that the supply picture will be brighter soon. Natural rubber is, of course, the tightest, and synthetic types are again being used wherever possible. The continued required use of synthetics after World War II has resulted in greatly improved synthetic rubber, which is replacing natural rubber for many purposes.

There are now around 640 different types of the GR-S type synthetics, and in many applications which require special properties, such as oil resistance or resistance to high temperatures, there are types that are superior to natural rubber. For the majority of uses, either natural or synthetic can now be employed satisfactorily, and the type used will depend on the immediate supply picture and the relative cost.

Synthetic rubbers have one weakness—a high hysteresis loss as compared to natural rubber. This characteristic, for example, increases the operating temperature of tires and can cause premature failure. To counteract this disadvantage, tire designs have been changed and cotton cord has replaced rayon in the carcass.

A promising recent advance has been the development of a new type of synthetic, called "cold rubber". It is polymerized at around 40 F, instead of around 120 F used for conventional GR-S, and has many excellent properties. Cold rubber has about 35% greater tensile strength, and a reported 30% better wear resistance than natural rubber. It can be used in such products as belting, footwear and wire insulation. It is particularly good in belting that must have high resistance to abrasion. Recently, methods have been developed to make foam rubber from cold rubber; formerly only natural rubber latex could be used. Like conventional GR-S, cold rubber still has hysteresis properties inferior to natural rubber.

Some cold rubber using polybutadiene has been made, but it is still in the evaluation stage. The main advantage would be the saving of styrene, which is badly needed by the plastics industry.

Butyl type synthetic rubber was also introduced during the last war and has proved itself as a satisfactory alternate for natural rubber in certain applications. It is now being used almost entirely for inner tubes.

Reclaimed rubber, both synthetic and natural, is suitable as an alternate for new rubber in such products as mats, flooring, and many mechanical goods. Reclaimed rubber does not have properties equal to those of new rubber, and should not be used where high abrasion resistance, high resilience, and high elongation are required.

# How Alternate Materials Can Help

## Steels and Irons

The plain steels and irons that contain very little or no strategic alloying elements again must be relied on heavily as replacements for the scarcer metals and alloys. But the fact that steel and iron are so widely used as alternates causes them to be in great demand, so that they, themselves, are becoming increasingly hard to get.

Wrought and cast steel, cast iron and malleable iron are all being used as alternates for aluminum. There is a definite swing back to gray iron automotive parts, such as crank cases and pistons, that were formerly made of aluminum. Some of these change-overs will probably be permanent because of cost considerations.

Shell molding techniques with gray iron permit casting thin-walled complex components to unusual dimensional accuracy. This means that gray iron also warrants consideration as an alternate for zinc and aluminum die castings.

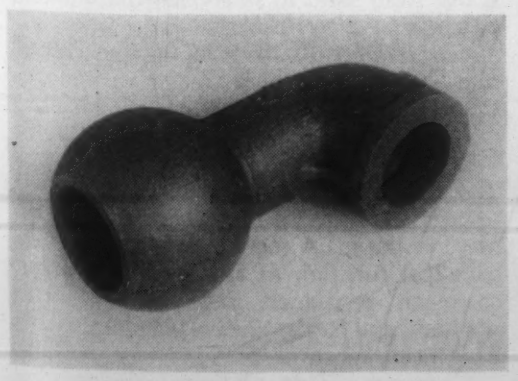
Nodular iron developments are progressing rapidly, and this relatively new ferrous metal has already been adopted in place of alloy steel castings and forgings for many uses. In one case a large spiral bevel gear, formerly a 4140 alloy steel forging, has been replaced by a ductile iron casting.

Quality controlled cast iron, commonly called Meehanite, is also an excellent alternate material. A good example is its use to make a flexible joint in a locomotive steam line. In service the casting must stand up under 250-lb steam pressure at 450 F. The casting was previously made of manganese bronze, and later of stainless steel. Now a Meehanite casting has been adopted and is giving satisfactory service.

There are instances where there is a scarcity of rolled and forged steel products. In such cases the solution might be to switch to a cast steel or an iron casting. This was illustrated earlier under the section "Redesign to Another Form".

Plain carbon steels plus protective coatings are already being used in thousands of places instead of critically scarce alloy and stainless steels. Also, high carbon steels lend themselves to selective or surface hardening and are finding increased adoption as alternates for the alloy steels. Change of design, change of fabricating methods, and increasing section thicknesses should not be overlooked for they can often provide the means of switching from an unavailable metal to a plain carbon steel.

Since many specific examples of where steels and irons can replace scarcer materials are given throughout this article, no listing of them will be made here.



*This steam line fitting, formerly made of manganese bronze and later stainless steel, is now a Meehanite casting.*

## Plastics

Plastics are scarce, and it's debatable whether to treat them as an alternate material or as an unavailable one for which substitutes must be found. Actually, they are in both categories. Many of the plants contacted are still able to get sufficient supplies of plastics and are using them to replace unavailable metals. In others, alternates for plastics are being sought. Many plants are tooling up for one or two different metals plus plastics so that they can switch back and forth, depending on supply.

Of the plastics, the scarcest seem to be polyesters, styrenes, phenolics and acrylics; although also short, the vinyls and cellulosics are somewhat more plentiful.

Resin suppliers are being extremely conservative to avoid misapplications of plastics. During the last war plastics were often used indiscriminantly as substitutes, and the failures that resulted from misapplications set back the industry right after the war. So that this is not repeated, the plas-

*The fiber glass-reinforced polyester resin housing, used for a Fairchild photo-electric engraver (left) replaces the aluminum housing (right). (Owens-Corning Fiberglas Corp.)*

tics industry is insisting that plastics be treated as a basic engineering material supplementing wood, metal, fibers and ceramics. As with these other engineering materials, plastics have characteristic properties, design requirements and fabricating methods which must be carefully considered in relation to a given application.

Plastics have been adopted permanently for many military items, such as gun stocks and grips, cable insulation, reflectors, lenses, medical tubing, mess hardware, body armor, proximity fuses and mine detectors. By being used in these items, plastics are saving many thousands of tons of metals, including steel, copper and aluminum, as well as other nonmetallics such as rubber.

The extensive adoption of plastics in refrigerators is a good example of how plastics can take the place of steel, plated metals, aluminum, zinc die castings and rubber, and, in many cases, improve performance. High pressure laminates have replaced porcelain enameled steel sheet inner door liners; plastics have replaced stainless steel lock-bolt rollers; and polystyrene plastics have replaced porcelain enameled steel evaporator doors. In a syrup dispenser the body sleeve, end plug and adapter bushing are now made of a clear acrylic plastic replacing stainless steel and aluminum.

In recent years, reinforced plastics, consisting of resins and reinforcing materials, such as glass fiber, cotton, hemp, rayon, sisal and paper, have successfully replaced steel, aluminum and other materials in a wide variety of applications, because they offer such properties as high strength, dimensional stability, impact resistance, light weight and good resistance to weathering and many chemicals. Therefore, reinforced plastics are valuable materials for replacing scarce

## Caterpillar's Well Established Program Involves Extensive Tests of Alternates

The basic policy followed by Caterpillar Tractor Co. in its continuing program to find alternates for critically scarce materials is that the dependability and durability of its products will not be lowered by adoption of such materials. Therefore, before final adoption, all alternate materials and designs undergo satisfactory laboratory and field tests.

Since Caterpillar's program of seeking satisfactory noncritical materials for specific parts or components has been going on almost continuously for the past 12 years, many of the so-called substitutes have now become standard practice. Here are some of the specific replacements being made for scarce materials:

*Nickel*—To avoid the use of high nickel steels, boron steel of the 86B45 type has replaced 4340 and 2345 nickel steels in 3½- to 6-in. dia shafts. Boron steels have replaced for 7 years alloy steels of the 4140, 3140 and 8640 types for bolts and capscrews at the rate of 500 to 1000 tons per month. End bits, formerly made of oil quenched 8645 steel (0.5% nickel), have been changed to medium carbon 1045 steel specially water quenched to obtain a differential hardness pattern. For the past eight years lean alloy gear steels have been used in place of 4820 steel (3.5% nickel).

Alloy iron with 0.5% max nickel is replacing 1.5% nickel-chromium alloy for clutch plates. "Shell" hardening techniques have been adopted in order to use 1045 carbon steel in place of 3.5% nickel steel in large sprocket shafts and final drive gears. The techniques employed involve special quenching or induction heating and hardening.

*Copper*—To save copper, bronze worm gears have been changed to high strength cast iron on two production models. The use of copper tubing in oil lines has been reduced by changing to copper brazed steel tubing. Bronze filter metal in oil filters has been replaced by "Micronic" paper type filters, with a consequent saving of 13,000 lb of bronze per month. The use of bronze has also been reduced by substituting steel-backed bronze bearings for the solid type. Finally, a large number of bronze castings have been changed to ferrous materials.

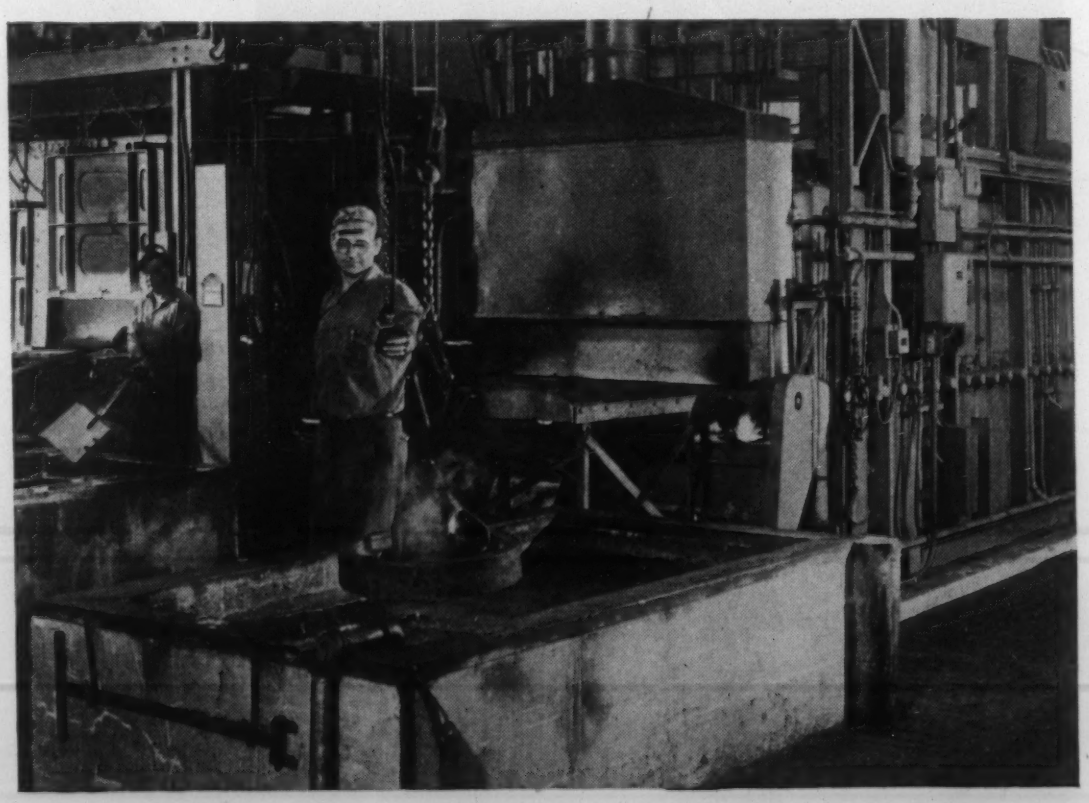
*Tin*—All engine bearings, formerly 90% tin babbitt, have been replaced by aluminum alloy bearings containing only 7% tin. The usage of tin has been further reduced by going to steel-backed aluminum bearings. All production soldering is now done with 30 tin-70% lead solders rather than with 50 tin-50% lead. Satisfactory techniques have been developed to obtain good bonding strengths with the lower tin content solders.

*Molybdenum*—To save extremely scarce molybdenum, plain carbon forgings have replaced 0.60% molybdenum steel castings. Also, the specifications on alloy steels containing 0.20% or higher molybdenum have been revised to allow the reduction of molybdenum contents down to a mean of 0.125%. 1.5 nickel-0.3% molybdenum iron liners hardened by oil quenching have been replaced by 0.50 nickel-0.16% molybdenum hardened by water quenching.

*Aluminum*—Cast iron has replaced aluminum wherever practical, such as in various covers and in some worm gears. Use of aluminum has been reduced by going from solid to steel-backed aluminum bearings.

*Chromium*—40 to 50% of the chromium content has been saved in tonnage steel, such as 4140 and 5160, by adopting the leaner alloy steels, such as 8600 for items like spring clips, studs and springs. The thickness of chromium plate has been reduced by about 50% where wear resistance is the main requirement. Where the principal function of chromium plating is corrosion resistance, such as on thrust washers and seals, Parko-Lubrite finishes have been substituted.

*Cadmium*—Zinc plating is being used as an alternate for cadmium plate. In other cases Parko-Lubrite finish is used. Also, phosphate coating and painting have been adopted for certain parts.



***Use of alternate steels has required many changes in heat treating methods.***

metals. However, reinforced plastics, themselves, are scarce; some reports indicate that considerably more will be available the latter part of this year.

Here are a few examples of how reinforced plastics have replaced other materials:

An aluminum housing for an electronic engraver was formerly fabricated by welding together five separate aluminum stampings. It is now a fiber-glass reinforced polyester resin molding. The change-over resulted in more uniform tolerances, fewer rejects. No finishing is required, and the reinforced plastic has greater resistance to denting than the aluminum.

A drip pan and a rear cover for an accounting machine, formerly made of aluminum, have been replaced by fiber-glass reinforced plastic moldings with considerable weight saving. The drip pan, made of an aluminum casting, weighed 13½ lb as compared to 6 lb when made of reinforced plastic. The rear cover of aluminum weighed 9 lb; made of reinforced plastic, it weighed 4½ lb.

A dust bag cone, for a tank type vacuum cleaner, which was previously made of 1/16-in. aluminum, is now made 3/32 in. thick with fiber-reinforced polyester resin molding compound.

## Rubber-Plastic Blends

In the last few years several materials composed of a blend of plastics and rubber have been introduced. Their high mechanical properties suit them as possible replacements for certain plastics and hard rubbers as well as metals. They combine good corrosion resistance, toughness and dimensional stability.

Some of the typical applications in which they replace metals or plastics are tote boxes, bathroom fixtures, kick plates, gears, valve seats, and seals. In one particular application a blend of styrene copolymer resin and acrylonitrile rubber replaced metal pipe in a processing plant. Although thermoplastic, service temperatures were low enough to permit its use, and its high resistance to chemicals resulted in increased service life over the metal pipe it replaced.

## Finishes and Surface Treatments

The job that finishes and coatings are doing to permit the use of non-critical materials in place of scarce materials has been touched upon in a number of other places in this article. Already mentioned have been the use of clear organic finishes over alternate nickel plates, the use of corrosion resistant coatings, and the availability of enamels that produce a finish resembling chromium. These synthetic enamels are already being used in place of chromium plate on hardware, lamps, metal furniture and automotive parts.

Finishes are also available for zinc and steel which simulate the appearance of copper, brass and bronze, and which are reported to have satisfactory resistance to weathering in many applications. Wrinkle finishes are a versatile group of coatings that are widely applicable on industrial instruments and equipment, photographic equipment, air conditioning units, electrical devices, office equipment, and many other places where stainless steel and aluminum might otherwise be used.

Metallizing is another means of replacing scarce metals. For example, a name plate, formerly made of a painted aluminum stamping, has been changed to a clear plastic molding which is metallized on the underside to give the appearance of chromium plate.

Organic finishes and chemical surface treatments can replace galvanized steel in many cases. And specially formulated lacquers and enamels are replacing tin coated containers where service conditions permit.

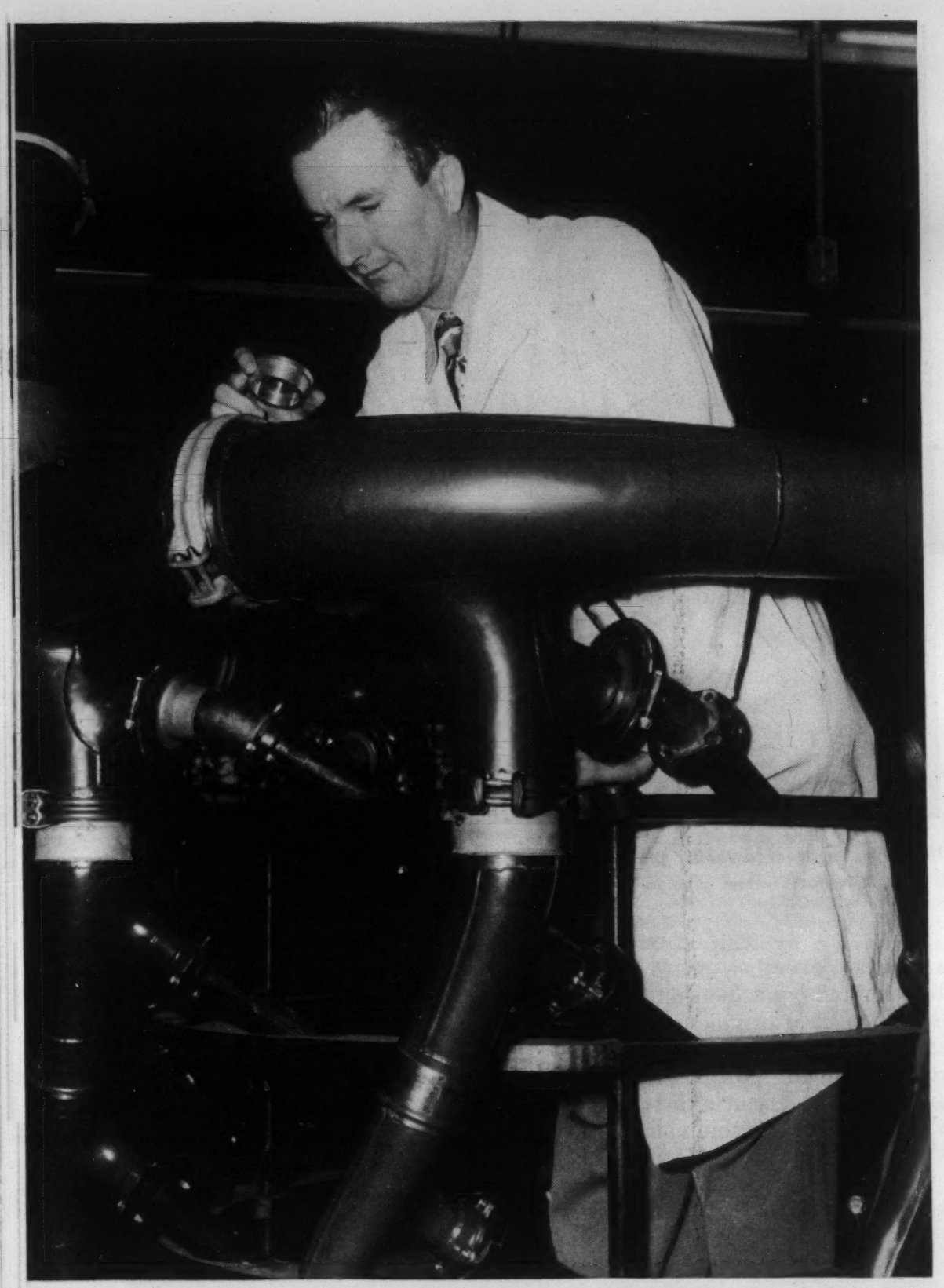
A new aluminum coating has been developed which is being considered as a possible substitute for nickel and chromium plating. The coating is bright, but not as brilliant as chromium, and it is more conservative of aluminum than usual aluminum paints.

Finally, there are virtually hundreds of different types of surface conversion and metal coloring treatments which should be considered when searching for ways and means of overcoming materials shortages.

*This pipe, made of a rubber plastic blend, has high toughness and chemical resistance. It replaces metal pipe in a chemical processing plant. (U. S. Rubber Co.)*

## Porcelain Enamels

Porcelain or vitreous enamels on mild steel or iron are often a suitable alternate for scarce metals in applications where corrosion and/or heat resistance is involved. Acid resisting types of porcelain enamel can be formulated to resist attack from most chemicals, including those encountered in the food, chemical, pulp, paper and dye industries. They are highly resistant to such common chemicals as sulfuric and nitric acids.



*Thin ceramic coatings are increasing the life of exhaust manifold systems built by Ryan Aeronautical Co.*

Because of their resistance to such a wide range of chemicals, porcelain enamels became recognized during the last war as a reliable alternate for stainless steels and other corrosion resistant metals. In many cases porcelain enameled steel replaced a scarce and more expensive metal or made possible a thinner section, thus saving critical materials.

In general, porcelain enamels are attacked by chemicals containing free caustic, and, therefore, should seldom be considered as an alternate where there will be long exposure to alkaline solutions. There are, however, some special alkali resistant enamels that have been developed for such uses as hot water heaters and laundry tubs.

Among the most interesting recent porcelain enamel developments is the use of specially formulated coatings on parts operating up to as high as 1900 F. Heat resistant ceramic coatings, as they are called, advanced rapidly during World War II and saved many tons of strategic heat resistant alloys. Porcelain enameled steel was adopted for steam boiler pre-heater parts, for aluminum melting pots, for exhaust manifolds, mufflers, and similar parts which were in contact with hot exhaust gases. An interesting heat resistant use of porcelain enamel is for coating nitriding equipment made of ordinary iron, thus replacing scarcer special heat resistant alloys.

Ryan Aeronautical Co. has been testing ceramic coated exhaust manifold systems for a number of months now, and their results have been encouraging enough to merit production of certain assemblies with ceramic coatings.

The excellent abrasion resistance of porcelain enamels makes them likely alternates for scarce abrasion resistant alloys and steels. Porcelain enameled steel is finding increased use for materials handling. For example, porcelain enameled chutes, spouts and liners have been found satisfactory for handling such things as coal, grain, concrete and cement, foods and liquids. They can also replace strategic alloys in heat exchangers, idler rollers of various kinds, pipes, fittings and valves, and guides for fabrics. There are many other possible uses, too numerous to mention.

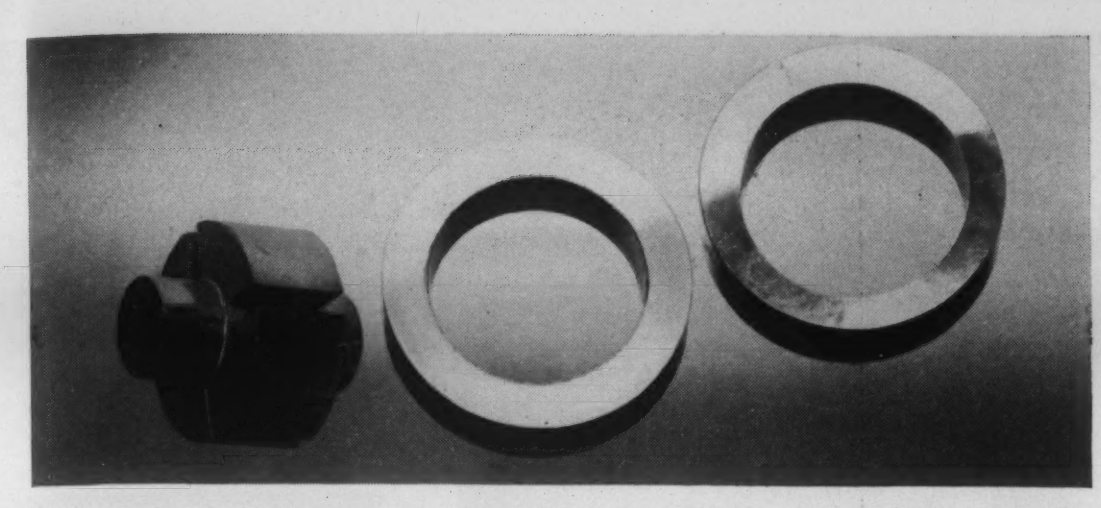
Porcelain enameled steel or iron is also a possible alternate for critical nonferrous metals, such as copper alloys. A typical example of this is pickling tank fixtures, which have previously been made of special bronze alloys but can now be produced of cast iron or forged steel finished in acid resisting porcelain enamel.

Cobalt oxide is an essential ingredient in porcelain enamel ground coats. Since cobalt is extremely scarce, the industry is making use of certain cobalt-nickel ores, called concentrates, which cannot economically be processed for their metal content. These are mixed with a minimum quantity of pure cobalt oxide. This type of ground coat has been successfully used, although it does not equal in quality that made by using all pure cobalt oxide.

## Powder Metallurgy Parts

Although metal powders are at present in great demand, they are still available in sufficient amount and are not controlled. Iron and brass powders can be considered for a wide variety of mechanical parts, such as gears, cams, ratchets, pistons, sprocket wheels, small housings, guides and pinions. Parts normally range from less than an inch in diameter up to 5 or 6 in.

One of the most promising uses of powder metallurgy to conserve critical metals is the possible adoption of iron powders in place of gilding metal for shell rotating bands. The Army Ordnance Corps is



*This water pump rotor and water pump lines, being produced of nickel-silver powder by United States Graphite Co., replace monel machined parts, resulting in considerable saving of nickel. (New Jersey Zinc Co.)*

thoroughly investigating this possibility, and to date there are definite indications that sintered iron bands perform better than copper on high velocity projectiles.

Large amounts of high temperature alloys are being conserved by using copper infiltrated iron for certain jet compressor blades. They replace a forging of type 403 stainless, which contains 13% chromium. These infiltrated iron materials have high strength and ductility and should find other uses where they can replace alloy steel parts.

In recent years, the French have developed permanent magnet materials composed of super-fine (submicron) iron powder. Magnets made of this iron have properties that are between those of Alnico 4 and Alnico 5, and, therefore, offer a means of replacing magnets containing critically scarce cobalt and nickel.

A typical example of reducing the use of scarce metal is that of a water pump rotor and two pump liners formerly machined from monel metal. By making the parts of nickel-silver powder, a considerable saving in nickel was realized, and machining waste almost entirely eliminated. The close tolerances and corrosion resistance were maintained, and according to the producer, there was a 72% cost saving realized over the former part.

## Glass

Glass is a more versatile material than is often realized. An appraisal of its properties, such as high hardness, good chemical resistance, and excellent resistance to abrasion and aging, show that it can serve as an alternate for many metals and plastics.

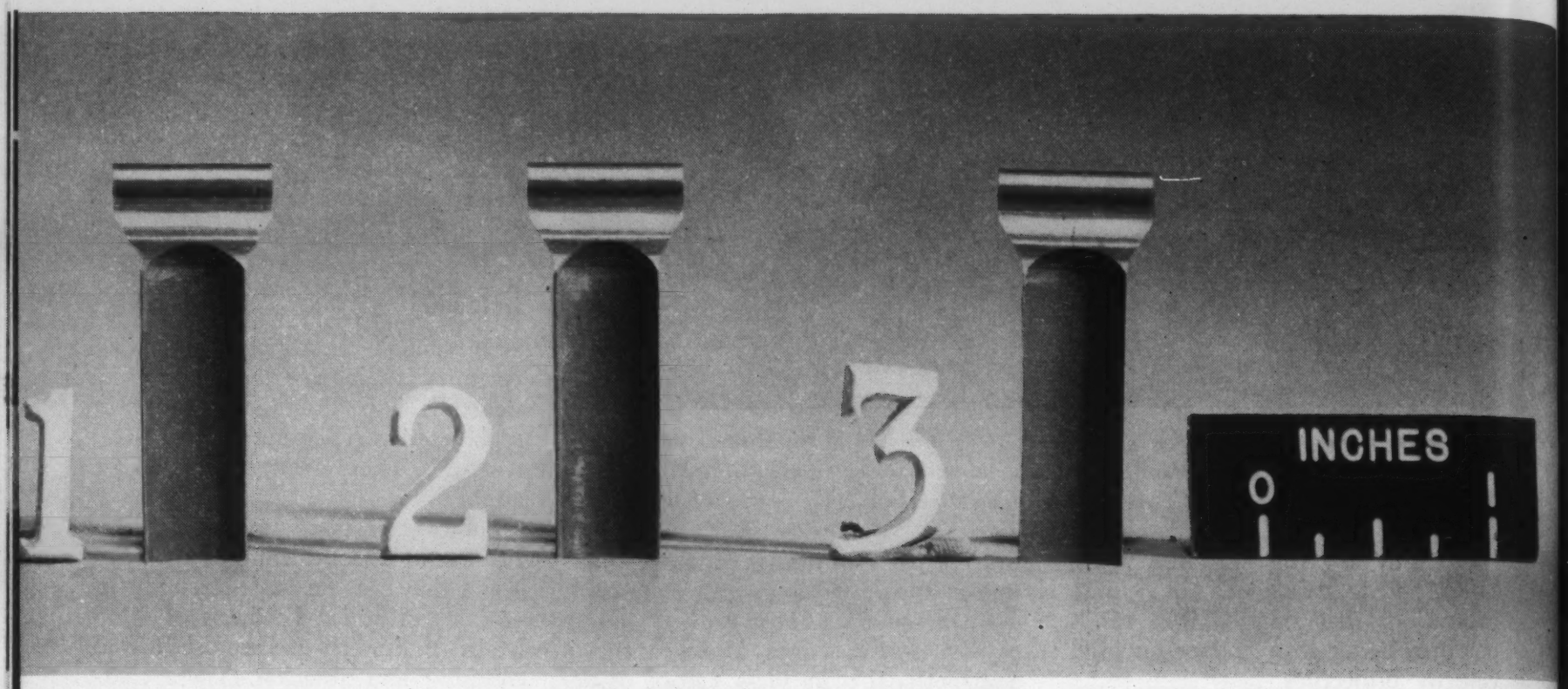
Some of the obvious uses of flat glass to replace scarce metals include shelving in cabinets, casings for heating furnaces, linings for plating tanks, tops for tables and counters, and record disks. Heat treated glass, which is five times stronger than conventional plate glass, can be used for kick plates on doors, balustrades, and range doors. Wire glass can be used for stair treads. In some applications glass tubing can replace brass or copper tubing. Instrument panel backboards, solid and laminated, can be made of glass. A recent development has been that of thin strips of lead glass of very high resistivity to high frequency electric current. These strips have been used as dielectrics in small condensers, replacing scarce mica for this purpose. Design characteristics of the glass are quite close to those of the mica. In many tanneries, polished plate glass has replaced aluminum and stainless steel for drying racks.

## Ceramics

In general, the supply of technical ceramics is adequate to meet present demands and, therefore, should be considered as replacements for scarcer materials where their properties are applicable. In certain applications ceramics can replace tungsten carbide. For example, some alumina type ceramics have a flexural strength of 45,000 psi and a hardness of 9 on Mohs' scale. They are resistant to chipping and abrasion. These characteristics suit them for use as extrusion nozzles in place of scarce tungsten carbide for extruding such things as ceramics, soft wires and pencil leads. These same ceramics can be used for thread guides, wire recorder guides and similar applications.

In uses where wear resistance is involved, ceramics can often replace

*Glass is a good replacement for aluminum, stainless steel, and other corrosion resistant alloys. Here is a polished plate glass drying rack being used in a tannery. (Libbey-Owens-Ford Glass Co.)*




*Much study is being devoted to development of ceramic-metal combinations to replace critical high temperature alloys. Shown here are some typical ceramal blades now under investigation by NACA.*

steel. On critical dimensions which lend themselves to grinding, ceramics can be produced with the dimensional accuracy of precision metal parts and thus have successfully replaced steel.

Another field where ceramics can be a successful replacement for strategic metals is in high temperature applications. These include a great variety of burner tips and nozzles, welding tips, and in jigs and fixtures for brazing. The recent developments in high temperature-high strength ceramics and ceramic-metal combinations make them possible alternates for critical high temperature alloys in jet engines, gas turbines and rockets. The study of these special ceramic materials has just started, and problems such as joining ceramics to metals and improving heat shock resistance must still be worked out before wide use of them is made.

Another example is the use of ceramics in place of cast iron for surface plates. Ceramic surface plates are as accurate as other types and, in addition, are light in weight and are relatively unaffected by chemicals or temperature changes.

## Carbon and Graphite

The use of carbon and graphite parts in the chemical and metallurgical fields is well established, but not so well known are some of the mechanical uses to which this versatile material can be put. Many types of bearings and valves, particularly those which operate under corrosive conditions, are made of carbon and last much longer than parts made of metals or plastics. Gland packing rings, piston rings and compressor stuffing box packing rings are other well established uses. Some of the newer uses include rayon finishing mill bearings, pouring spouts, rings for sealing fluorescent tubes, and gears for metering devices handling corrosive fluids. Ball thrust bearings on automobiles have been replaced by carbon clutch rings which provide long life and have the required low friction qualities. Carbon is also used for dies and molds in the field of powder metallurgy, particularly where pressures must be exerted at high temperatures. Carbon withstands pressures of 1000 psi at temperatures up to about 2200 F.

Here are some examples: The rotor part of a steam valve was redesigned for the use of carbon-graphite material. The change resulted in a cost reduction of 57% over the original part made of Type 303 stainless steel. In addition, the part gives four times the service life.

The valve seat of a service station gasoline pump was formerly made of bronze. A slight redesign made the use of a carbon-graphite material practicable. Although costs were almost identical, the changeover resulted in an impressive drop in service complaints.

These are changes that should have been made during the normal course of product development, but probably would not have been had there not been some pressure exerted to find alternate materials. In all of these cases the substitute proved better than the original.

## Wood Products

Like most engineering materials these days, wood products are in short supply. However, the supply appears to be better than many metals, and, therefore, they should be considered as possible alternates.

Plywood panels have already found countless applications in product design where they have been selected in competition with metals. An outstanding example is the use of plywood in Pressed Steel Car Co.'s Unicel car. This railroad car has "stressed skin" construction. In this type of construction plywood is glued or welded to a framework forming a diaphragm in which all parts are integral features of the whole structure. Besides many performance and operating advantages, this type of construction saves approximately 11 tons of steel per car. During World War II plywood served as an alternate for steel in thousands of life boats. It can be used as a source of strength and rigidity in hundreds of items, such as trunks, cases for portable radios, baffle plates in television sets, vending machines, chutes, storage bins, jigs and fixtures, instrument boards, patterns, templates and mock-ups.

Another group of wood products that are a promising alternate for metals are the wood sheet hardboards, often referred to as Masonite. These hardboards are available

in a number of different grades. A die stock hardboard is manufactured which is suitable for metal dies used in bending and stretching sheet metals, drill fixtures, templates and mock-ups. Other types of hardboards can and are being used in place of steel and aluminum in automobiles, furniture, transportation equipment, toys, and hundreds of other items.

Metal-wood composites are valuable materials for stretching available supplies of scarce metals. They are available in a wide range of compositions. The metal can be sheet steel, with or without a surface finish, aluminum, stainless steel and copper. The wood portion can be plywood, Masonite or other types of fiber boards. The construction of the core can be either solid or honeycombed.

Besides the sheet forms just discussed, wood can be used as an alternate in many other forms. Impregnated wood bearings is an excellent example. They should be given serious consideration in many types of light to medium duty service. Wood bearings for this kind of service range from inexpensive types used in baby carriages to precision impregnated types that compete in tolerances, life, anti-friction properties, and self-lubricating qualities with metal powder, plastic and babbitt metal.

***Plywood, because of its rigidity and strength, is a natural alternate for steel in railroad car construction. (Douglas Fir Plywood Assn.)***

# Conservation Programs of Philco and RCA Have Successfully Reduced Use of Strategic Materials

Several months ago both the Philco Corp. and the Radio Corp. of America completed extensive conservation programs in which their television receivers were completely redesigned with the object of eliminating or reducing to a minimum the use of critical materials. Given briefly below are a number of the specific changes which resulted in considerable savings of scarce materials. Many of the changes were made by both companies. Others were made separately.

## Chassis

*Alnico 5*

1. Magnet in RCA speaker was reduced from 2.5 oz of Alnico 5 (24 cobalt, 14 nickel, 8 aluminum and 3% copper) to approximately 1 oz. Philco speaker magnet was replaced by using electromagnetic speaker.

2. Permanent magnet focuser was replaced by new electrostatic focusing circuit.

3. Beam bender changed to Alnico 3, which contains no cobalt.

*Copper*

1. Smaller filament transformer and voltage doubler power supply using selenium rectifiers replaced large power transformer.

2. Hook-up wire throughout chassis reduced from 22 to 24 gage.

3. Copper clad steel wire instead of copper wire leads on wire-wound resistors and chokes.

4. Shorter mounting bushings on some variable controls to save brass.

5. Length of wire leads on tubular and mica condensers shortened.

*Aluminum*

1. Aluminum frame assembly straps replaced by fabric straps.

2. Protective cup for picture tube replaced by plastic or plastic-and-fiber cup.

3. Amount of aluminum foil in certain electrolytic condensers reduced by use of lower voltage plate power supply.

*Tin*

Considerable tin is being saved by using a 20% tin solder with a new flux instead of the former 40% tin solder.

*Zinc*

Zinc is being saved by eliminating some die castings. All brass hardware and machine screw parts being replaced by steel wherever possible. Brass for decorative purposes being eliminated.

*Cadmium*

Cadmium plating is being replaced by a coating of non-critical material wherever soldering requirements permit.

## Tubes

*Nickel*

1. In receiving tubes, carbonized nickel-plated steel strip has been substituted for nickel as an anode material. The new material consists of a 10% nickel plate, coated with nickel oxide, bonded to aluminum deoxidized cold rolled steel strip. The bonded strip is carbonized. In some applications carbonized nickel-oxide coated steel (without nickel plating) is satisfactory. Work is being conducted in using aluminum clad steel strip in place of nickel for the anodes of certain tubes. Nickel plated iron wire (Nipron) is being used for inside stem leads. Study of Nipron for outside stem leads is underway. Attempts are also being made to use 18:8 stainless steel wire for certain non-critical tube components, such as getter loops.

2. In picture tubes, nickel plated iron wire is being used for inside stem leads. Bulb-spacer design is changed, reducing amount of 18:12 stainless steel by 50%. Gun design in one type tube is changed, reducing amount of 18:12 stainless by 70%.

*Copper*

1. In receiving tubes copper clad steel wire or nickel plated iron grid side rods are replacing copper wherever feasible.

2. In picture tubes glass is replacing copper in the exhaust tubulation. Diameter of Dumet stem leads has been reduced, saving 15% of copper formerly used.

## Installation

*Aluminum*

1. Steel antenna masts are being used in place of aluminum. Tall masts are being constructed of one size smaller aluminum tubing.

2. Steel cross arms are replacing aluminum.

3. Receiving elements and mounting hardware, formerly made of dural or butt-seam welded aluminum, are being replaced by steel and steel tubing.

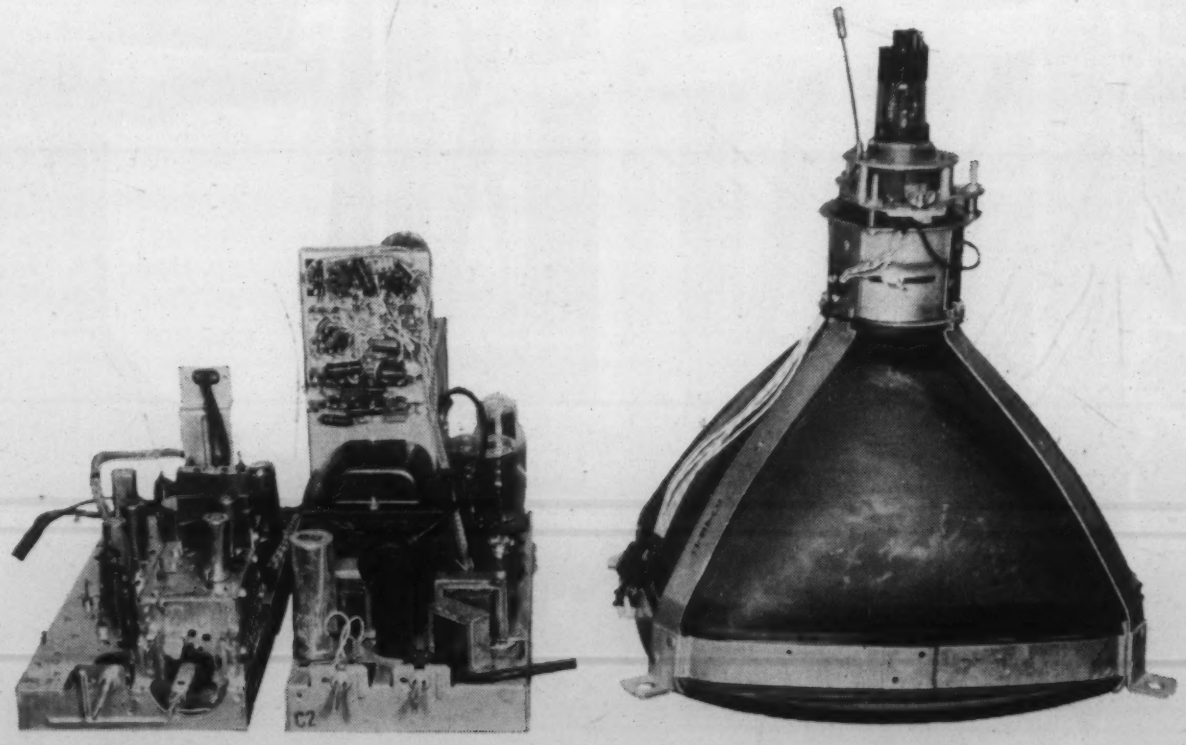
*Copper*

A program has been instituted to reduce the footage of cable used per job. The standard 300-ohm transmission line consisting of seven strands of No. 28 copper wire is being replaced by seven strands of No. 30 wire. Use of steel wire coated with thin layer of copper ("Copperweld") is being investigated.

*Zinc*

A plastic coating material is being used for rust-proofing steel masts and brackets instead of zinc coatings.

***Present Philco television receiver chassis has been completely redesigned in order to reduce or eliminate scarce materials required for it.***



## Noble Metals

The noble metals, which include gold, silver and the platinum group, have many useful properties for industrial use. Silver and silver alloys were quite extensively used as alternates in World War II. In recent years their use for electrical contacts has increased sharply. Pure silver is widely used, followed by coin silver, for this purpose. Silver electroplate is extensively employed as a coating for copper and brass in connection plugs and sockets for aircraft and the like. In some applications silver alloys and silver-lead oxide are possible alternates for tungsten and copper contacts. Silver and silver alloys offer an excellent alternate for copper and nickel-base alloys as base metals in rolled-gold plate. Rolled silver-clad steel strip up to 4 in. wide and thicknesses down to 0.005 in. is now available for such scarce metals as brass, nickel-silver and nickel alloy.

Platinum and palladium alloys serve as contact materials, and in certain applications can be used in place of tungsten and copper. However, it must be remembered that substitution of one contact material for another is difficult and usually requires some change in design. The platinum metals are also highly resistant to most chemicals and, therefore, can be considered an alternate for the scarcer corrosion resistant alloys where the amount used is small and the cost is not prohibitive.

## Heat Treating

Using alternate methods of production to overcome material shortages has already been covered in our discussion of "Redesign to Another Form". Also, ways of finishing and coating non-scarce materials to replace scarcer ones has been covered elsewhere. This particular section will be confined to the possible ways of replacing a scarce material by obtaining the desired properties through heat treatment.

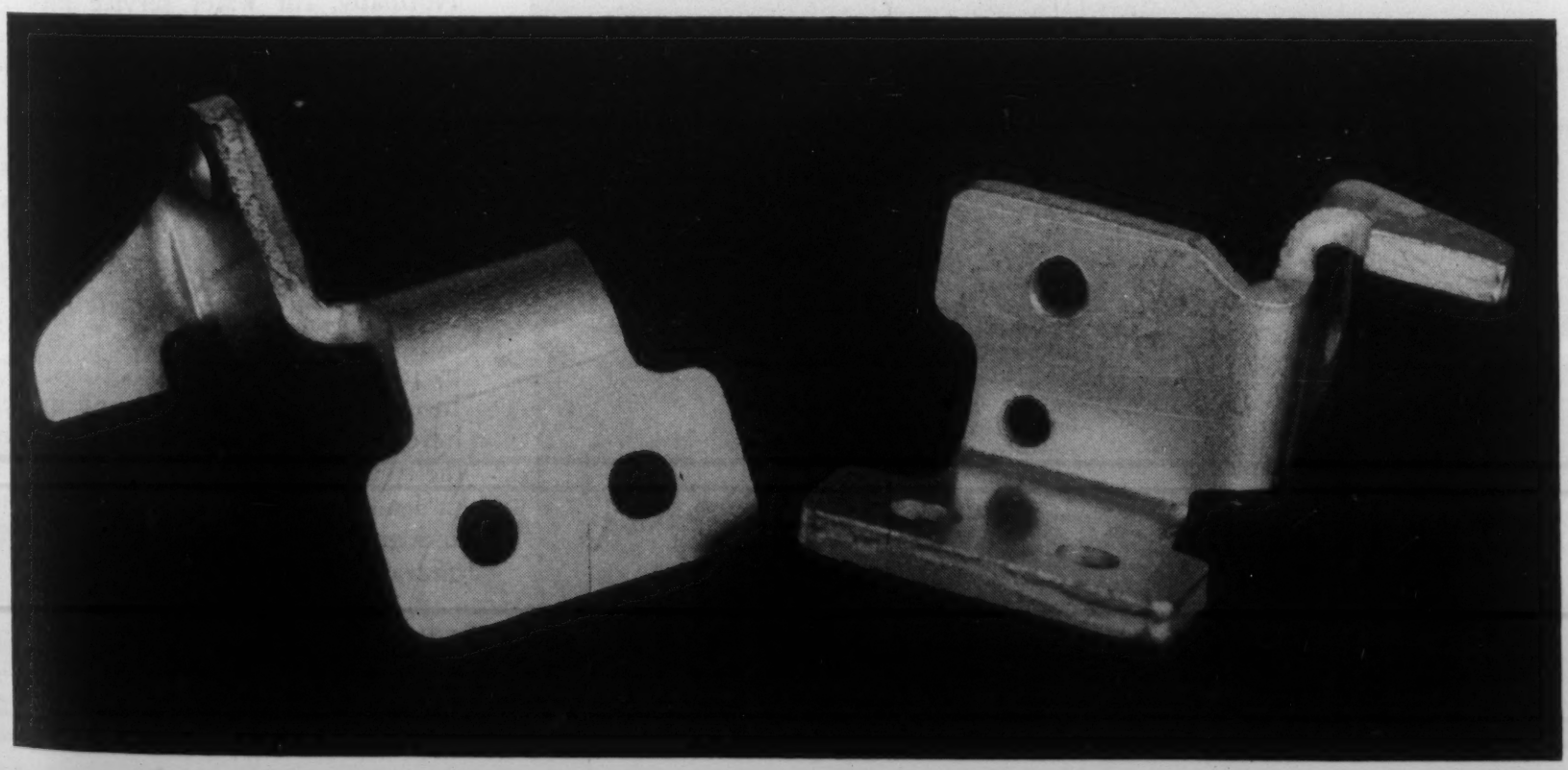
Surface and selective hardening is one method of saving scarce materials by heat treatment. Thus, instead of making a part entirely of a high alloy steel to obtain the required surface hardness, a carbon steel case-hardened by any one of several techniques will often prove quite satisfactory. For example, in the case of liners used in compacting silicon carbide lightning arresters, it was found that cold-drawn low-carbon steel tubing, case-hardened by carbonitriding, could satisfactorily replace both cemented tungsten carbide and tool steel.

An excellent example of how heat treating can be used as a means of overcoming material shortages is the use of homogeneous or through carburizing to develop high carbon properties in low carbon steels. Thus, where 0.30 to 0.85% carbon steels cannot be obtained, it is frequently possible to use a 0.10% carbon steel and by carefully controlled homogeneous gas carburizing increase carbon content throughout the section to the desired level. In many cases this method provides other advantages besides overcoming the immediate material shortage. Where intricately formed parts are involved, the use of a low carbon steel will likely reduce rejects, prolong die life, and permit simplification of designs. The extra cost of carburizing the low carbon steels after forming will, in most cases, be offset by lower material cost, lower tool maintenance and less scrap.

An application of this technique is now developing at International Business Machines Corp. Many of the small parts going into their business machines have been normally made of medium and high carbon steels to provide good wear resistance and relatively high strength and impact properties. For some time their engineers have been considering the use of lower carbon steels, particularly on intricately shaped parts which are difficult to form. This work has been hastened in recent months by shortages of the higher carbon steels.

The first part to be changed from high to low carbon steel is an escapement pawl bracket used in the electric typewriter. The part is produced on a punch press, and because of several sharp radii is rather difficult to form without cracking (see illustration). The part was originally made of 1065 steel. In order to cut down on the rejects, a 1050 steel was tried and rejects were reduced

*Through-carburizing of this escapement pawl, used in an electric typewriter, permits use of a low carbon in place of a high carbon steel. (International Business Machines Corp.)*



to around 5 and 10%. Now, with the adoption of low carbon (1010) steel, rejects will be practically zero.

## Magnesium

Magnesium is temporarily scarce, but it is believed that by early next year production will be increased considerably when a new rolling mill is scheduled to begin turning out wider and longer sheet stock.

Magnesium rolled products are likely alternates for aluminum, steel and plastics. In transportation and materials handling equipment, magnesium is an excellent alternate and in many applications has replaced steel and aluminum permanently. Magnesium can frequently replace steel or aluminum in housings. For example, magnesium proved to be the best material for a teletypewriter housing. The base is a single sheet, 0.081 in. thick, with a rolled edge and formed stiffening ribs. The cover is drawn in one piece from FS magnesium alloy, 0.064 in. thick with a draw about 14 in. deep.

Magnesium, aluminum and zinc die castings have become close competitors in recent years, and, therefore, magnesium is well adapted for many parts formerly made of aluminum or zinc. Some typical die cast parts in which magnesium can be used interchangeably with aluminum and zinc include end bells for fractional-horsepower motors, spools for wire and textiles, pump cases, field rings, toys and novelties.

All of the wrought magnesium alloys can be extruded and, therefore, can be considered as alternates for aluminum and copper alloy extrusions for a wide variety of applications.

A finish for magnesium recently announced by the Army Ordnance Corps should help extend the use of magnesium as a replacement material. The new coating, known as HAE, is applied electrolytically much the same as aluminum alloys are anodized. The outstanding characteristics of the coating are its excellent corrosion resistance, high hardness, high melting point and good dielectric strength.

***Magnesium, although temporarily scarce, is a likely alternate for steel and aluminum in such products as this teletypewriter housing. (Brooks & Perkins, Inc.)***

## Fibrous Materials

Fiber boards, vulcanized fiber and other fibrous materials are useful alternates for plastics and metals. Most fibrous materials are made in sheet and tubular form, and can be machined, formed and fabricated with standard metal working equipment.

Fiber board sheets can satisfactorily replace galvanized sheet steel and aluminum for housings, casings and duct work. Vulcanized fiber is suitable for certain types of gears and as an overlay in sandwich materials. A relatively new fibrous material known as Duroid, has many uses, particularly in the electrical field. For example, it has been found useful as a replacement for plastics such as polystyrene and nylon for electrical fitting insulation. Other possible uses of fibrous materials are given in the table of alternate materials.

## Lead

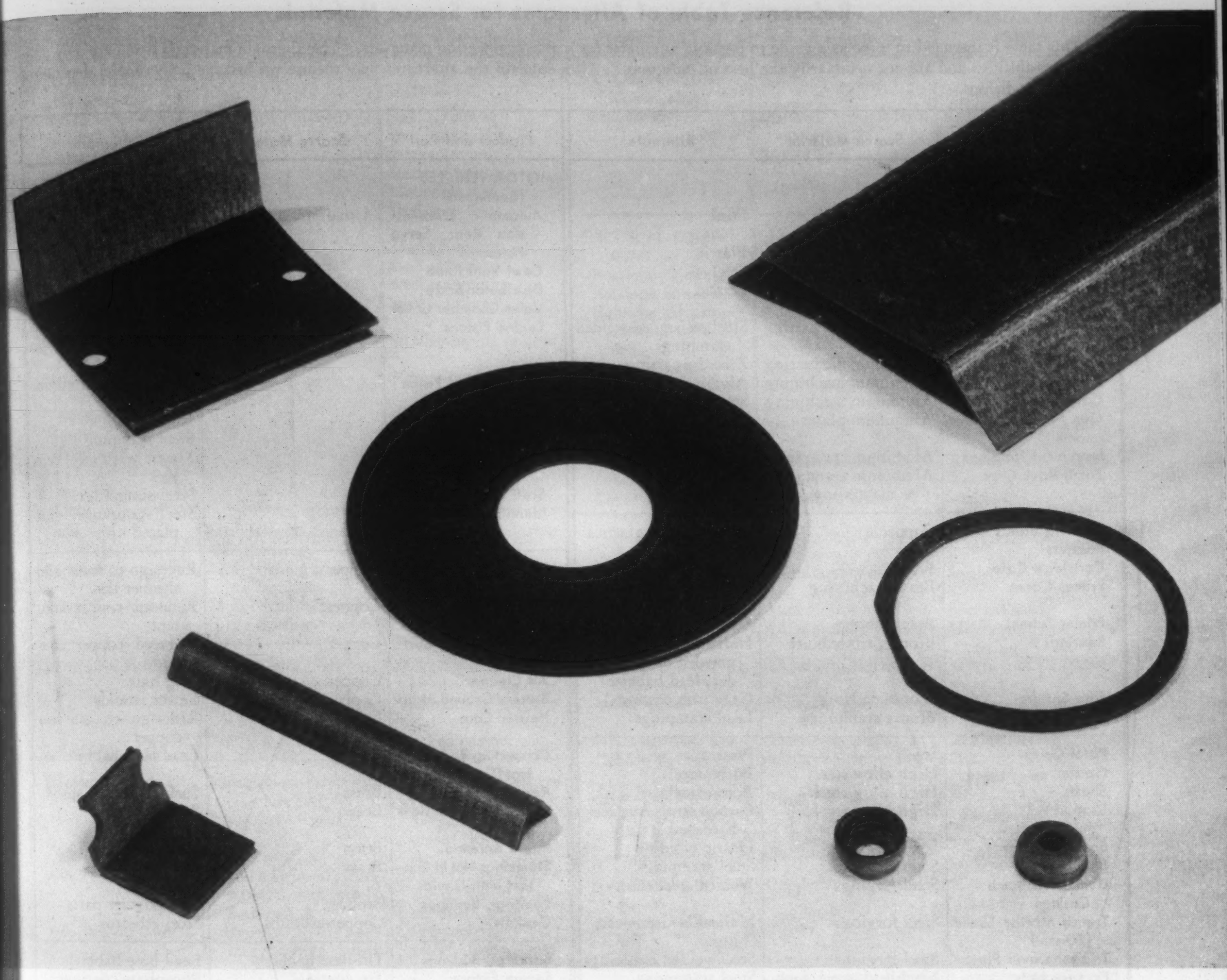
Lead has always been an important material for handling corrosive chemicals, and, therefore, is a natural alternate for scarce stainless steels, copper alloys and nickel alloys in many chemical and process industry applications. Pipe, heating or cooling coils, tank linings, plating tanks and waste recovery equipment are customary anti-corrosive uses. In many applications involving sulfuric and phosphoric acid, lead is being specified in place of type 314, type 318, and other stainless steels.

In the plumbing field lead is replacing copper tubing and pipe. Normally, for water service piping, copper, brass, galvanized iron and lead are suitable materials. Since the shortages began, lead is being used more extensively.

In waste systems, copper, brass, galvanized iron, wrought and cast iron, and lead are frequently interchangeable, and, therefore, lead along with iron is finding increased use.

Lead and copper have been the traditional materials for roof flashing. In recent years aluminum and monel have come into the picture. However, the tight supply situation has resulted in lead replacing copper, aluminum and monel where these materials are unavailable.

Lead, long an accepted material for foil, is rapidly replacing aluminum foil because of aluminum shortages. In the first four months of 1951 there has been a 125% increase over the



*Fibrous materials are useful alternates for plastics and metals. They can be formed and fabricated on metal working equipment. Here are a few typical parts made of Duroid. (Rogers Corp.)*

same period last year in the use of lead foil. Foil has many uses as a moisture barrier material, and for packaging and decorative purposes. The use of lead for collapsible tubes has had the same percentage increase as foil. Lead collapsible tubes are generally coated inside with an organic finish and find wide use for packaging many consumer and industrial products.

Another interesting alternate application is the use of lead-headed steel nails for fastening aluminum in place of aluminum nails with neoprene or lead washers.


## Acknowledgment

The following organizations, through their literature and personal help, supplied much of the information for this manual:

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Caterpillar Tractor Co.
Cooper Alloy Foundry Co.
Copper & Brass Research Assn.
Douglas Fir Plywood Assn.
Ford Motor Co.
Gas Machinery Co.
General Plate Div.,
Metals & Controls Corp.
General Services Administration,
Federal Supply Service
Graphitized Alloys Corp.
Gray Iron Founders' Society, Inc.
The Hoover Co.
Houghton Laboratories, Inc.
International Business Machines Corp.
International Nickel Co., Inc.
Johnston Glass Co., Inc.
M. W. Kellogg Co.
Lead Industries Assn.
Leake Stamping Co.
Lewyt Corp.
Libbey-Owens-Ford Glass Co.
Lionel Corp.
Lukens Steel Co.
Maas & Waldstein Co.
Malleable Founders Society
Glenn L. Martin Co.
Meehanite Metal Corp.
Molded Resin Fiber Co.
Munitions Board
National Bureau of Standards
National Production Authority
The New Jersey Zinc Co.
Norton Co.
Owens-Corning Fiberglas Corp.
Owens-Illinois Glass Co.
Philco Corp.
Pittsburgh Plate Glass Co.
Porcelain Enamel Institute, Inc.
RCA Laboratories Div.
Rigidized Metals Corp.
Ryan Aeronautical Co.
Scovill Manufacturing Co.
Steel Founders' Society
Stoody Co.
Surface Combustion Corp.
Tin Research Institute
United Aircraft Corp.
United Chromium, Inc.
U. S. Rubber Co.
U. S. Steel Corp.
Westinghouse Electric Corp.
Wire Coating & Manufacturing Co.
Yale & Towne Manufacturing Co.


**See following pages for the Reference Table of Alternates for Scarce Materials**

## Reference Table of Alternates for Scarce Materials

This table is intended to serve as a guide to possible alternates for scarce engineering materials. The alternate materials listed are only suggested possibilities and are not necessarily the best or only ones. Also, some of the alternates may themselves become unavailable, depending on future conditions.

| Product and Part | Scarce Material | Alternate |
|---|---|---|
| **ORDNANCE EQUIPMENT** | | |
| Armor-Piercing Shot | Aluminum | Steel |
| Windshield | | |
| Bomb Fuses | Aluminum | Plastic |
| Hand Wheels | Aluminum | Steel |
| Trench Mortar Shell Fuse Parts | Aluminum | Plastic |
| Bomb Tail Fins | Aluminum die casting | Steel resistance-welded stampings |
| Shell Fuse Plugs | Aluminum die casting | Zinc die castings |
| Artillery Shell Fuses | Aluminum machining | Aluminum die casting |
| Cartridge Tank | Aluminum machining | Steel stamping |
| Gun Mount Components | Aluminum plates | Steel ribbed stampings |
| Instrument Housings | Aluminum stampings | Reinforced plastic |
| Bomb Rack Clips | Aluminum stampings or die castings | Steel stampings |
| Rotating Bands | Copper | Iron powder, plastics |
| Boosters | Brass | Steel |
| Cartridge Cases | Brass | Steel |
| Primer Cases | Brass machining | Steel stampings assembly |
| Primer Tubes | Brass tubing | Steel stampings |
| Bearings | Bronze, tin babbitt | Indium-plate, iron powder, bronze powder, lead babbitt |
| Fuse Setters | Bronze castings | Gray iron castings |
| Name Plates | Bronze stampings | Lead stampings |
| Pistol Grips | Steel | Plastic |
| Gears | High alloy steel | Boron steels |
| Shafts | High alloy steel | Boron steels |
| Shot | High alloy steel | Carbon steels, surface-hardened |
| Bayonet Grips | Steel forgings | Plastic molding |
| Bomb Lugs | Steel forgings | Steel stampings |
| Demolition Bomb Casings | Steel forgings | Welded steel sheet |
| Trench Mortar Shells (60-mm) | Steel forgings | Malleable iron castings |
| Trigger Cover Plate | Steel forgings | Steel welded stampings |
| Fin Lock Nuts | Machined steel forgings | Steel stampings |
| Machine Gun Magazine | Machined steel forgings | Spot-welded steel stampings |
| Armor-Piercing Shot | Machined steel | Steel bar-forgings |
| Machine Gun Handles | Steel | Plastic |
| Smokeless Powder Container Liners | Tinned copper sheet | Stainless steel sheet |
| Ammunition Boxes | Tin plated steel | Fiber laminate coated with lead, wood, enameled steel |
| **MOTOR VEHICLES** | | |
| Front Cylinder Cover | Aluminum alloys | Iron casting or steel stamping |
| Fuel Pump Adapter | ↓ | Iron casting |
| Oil Level Indicator Boss | | Iron casting |
| Oil Filter Boss | | Iron casting |
| Starter End Plates | | Iron casting |
| Generator End Plates | | Iron casting |
| Automatic Transmission Extension | | Iron casting |
| Automatic Transmission Rear Pump Body | | Iron casting |
| Automatic Transmission Clutch Piston | | Iron casting |
| Automatic Transmission Rear Servo Body | | Iron casting |
| Automatic Transmission Rear Servo Piston | | Iron casting |
| Cowl Vent Knob | | Plastic |
| Distributor Body | | Iron casting |
| Valve Chamber Cover | | Iron casting |
| Engine Pistons | | Pearlitic malleable iron, steel and iron castings |
| Brake Wheel Piston | | Low grade aluminum castings |
| Cylinder Head | | Iron casting |
| Oil Cleaner Cover | | Steel stamping |
| Timing Gears | | Plastic with steel centers |
| Scuff Plates | | Steel stampings |
| Identification Plates | | Steel stampings—zinc plated |
| Radiator Fins | Copper | Redesign to fewer and thinner fins |
| Crankshaft (Steel Casting) | Copper | Reduced copper content |
| Camshaft (Iron Casting) | Copper | Reduced copper content |
| Air Cleaner | Copper | Hog hair |
| Battery Ground Strap | Copper | Fewer strands |
| Heater Core | Copper | Redesign to use less copper |
| Connecting Rod Bearings (Copper-Lead) | Copper | Lead-base babbitt |
| Radiator Tanks | Brass | Surface treated steels |
| Radiator Overflow Tube | Brass | Steel tubing |
| Radio Antenna | Brass | Steel tubing |
| Stampings Not in Contact with Liquids | Brass | Steel stampings |
| Bearings, Bushings | Bronze | Iron powder parts |
| Gaskets | Copper-asbestos | Steel-asbestos |
| Bearings, Bushings | Tin-base babbitts | Lead-base babbitts |
| Engine Pistons | Tin coatings | Phosphate coatings |
| Radiator Solder | Tin solders | Reduced tin content and added silver and/or antimony |
| Body Solder | Tin solders | Reduced tin content and added silver and/or antimony |
| Fuel Tank — Upper Half | Terne plate | Uncoated steel |
| Fuel Tank — Lower Half | Terne plate | Reduced coating thickness |
| Fuel Tank Baffles | Terne plate | Uncoated steel |
| Radiator Side Supports | Terne plate | Uncoated steel |
| Mufflers | Terne plate | Uncoated steel |
| Fuel Pumps | Zinc alloy die castings | Iron castings |
| Carburetor Air Horn | ↓ | Iron castings |
| Transmission Cover | | Iron castings |
| Shift Control Arm | | Steel forging |
| Defroster Funnel | | Steel stamping |
| Lock Switch Housing | | Iron casting |
| Radiator Grilles | | Steel stampings |
| Instrument Panel Grille | | Plastics; steel stamping |
| Steering Wheel Hub and Brackets | | Steel stamping; malleable iron casting |
| Horn Ring | | Steel stamping |
| Number Plate Bracket | | Steel stamping |
| Ash Tray Knob | | Steel stamping |
| Head Lamp Rim | | Steel stamping |
| Hood Ornaments | | Plastic |

| Product and Part | Scarce Material | Alternate |
|---|---|---|
| MOTOR VEHICLES—(Continued) | | |
| Parking Lamp Rim | Zinc alloy die castings | Steel stamping |
| Tail Lamp Housing | | Steel stamping |
| Heater Air Inlet Tube | | Steel stamping |
| Sun Visor Bracket | | Steel stamping |
| Hand Brake Handle | | Malleable iron casting |
| Door Lock Striker Plate | | Steel stamping |
| Medallion Frame | | Steel stamping |
| Name Plate | | Steel stamping |
| Door Handles | | Steel stamping |
| Window Regulator Handles | | Steel stamping |
| Main Bearing Oil Seal Retainer | | Steel stamping or fibre |
| Distributor Vacuum Control Diaphragm Housing | | Steel stamping |
| Windshield Wiper Pivot Arm | | Steel stamping |
| Deck Lid Handle Molding | | Steel stamping |
| Crankshaft | Molybdenum containing castings | Reduced molybdenum content |
| Camshaft | Molybdenum containing castings | Reduced molybdenum content |
| Valve Seat Inserts | Molybdenum containing castings | Reduced molybdenum content |
| Decorative Plating | Copper-nickel-chromium coatings | Nickel partially, or wholly replaced by increasing copper and using a clear baked enamel |
| Decorative Parts | Nickel-chromium stainless SAE 30301 | Straight chromium stainless—SAE 51430, or chromium plated low carbon steel |
| Axle Pinion | Chromium-nickel-molybdenum steels SAE 86XX | Lean triple alloy steels, boron treated, 80BXX |
| Axle Driving Gear | Chromium-nickel-molybdenum steels SAE 86XX | Lean triple alloy steels, boron treated, 80BXX |
| Differential Pinion | Chromium-nickel-molybdenum steels SAE 86XX | Lean triple alloy steels, boron treated, 80BXX |
| Differential Side Gear | Chromium-nickel-molybdenum steels SAE 86XX | Lean triple alloy steels, boron treated, 80BXX |
| Differential Pinion Shaft | Chromium-nickel-molybdenum steels SAE 86XX | Lean triple alloy steels, boron treated, 80BXX |
| Universal Joint Spider | Chromium-nickel-molybdenum steels SAE 86XX | Lean triple alloy steels, boron treated, 80BXX |
| Axle Pinion Gear | Molybdenum steels SAE 40XX | Lean triple alloy steels, TS-81XX, and lean triple alloy steels, boron treated 80BXX |
| Transmission Mainshaft | Molybdenum steels SAE 40XX | Lean triple alloy steels, TS-81BXX, and lean triple alloy steels, boron treated, 80BXX |
| Transmission Planetary Gears | Molybdenum steels SAE 40XX | Lean triple alloy steels, TS-81XX, and lean triple alloy steels, boron treated, 80BXX |
| King Pin | Molybdenum-nickel steels SAE 46XX | Lean triple alloy steels, TS-81XX |
| Bearing Races | Molybdenum-nickel steels SAE 46XX | Lean triple alloy steels, boron treated, 94BXX |

| Product and Part | Scarce Material | Alternate |
|---|---|---|
| MOTOR VEHICLES—(Continued) | | |
| Exhaust Valves | Nickel-chromium steels | Reduced nickel content, increased chromium and manganese (20 Cr, 2–5 Ni, 6% Mn) |
| ELECTRICAL EQUIPMENT | | |
| Housings, Control | Aluminum | Steel |
| Housings, Street Light | Aluminum | Steel, coated steel |
| Lightning Arrester—Casings and Fittings | Aluminum | Galvanized steel |
| Metal Sockets | Aluminum | Sheet steel |
| Street Light Brackets | Aluminum | Malleable iron |
| Street Light Hangers | Aluminum | Silicon bronze |
| Telegraph-Printer Bases | Aluminum | Cast iron |
| Floodlight Reflector | Polished aluminum | Silvered glass |
| Boxes, Terminal | Aluminum castings | Wood, cast iron |
| Circuit Breaker Contact Arms, Cross Heads, Supports, Frames, Hooks, Etc. | Aluminum castings | Steel |
| Relay Covers, Frames and Rotors | Aluminum castings | Steel |
| Brush Holders | Aluminum die castings | Formed steel |
| Floodlight Socket Housing | Aluminum die castings | Magnesium or zinc casting |
| Magnet Bearing Brackets | Aluminum die castings | Magnesium or zinc casting |
| Meter Bases | Aluminum die castings | Magnesium or zinc casting |
| Floodlight Lens Ring | Aluminum stamping | Steel stamping |
| Lighting Reflectors | Aluminum stamping | Phenol plastic, silvered glass |
| Meter (Watt-Hr) Cover Rings, Register, Seal Bar, Bayonets | Aluminum stamping | Steel |
| Transformer Conductors | Copper | Silver or silver laminates |
| Wire (Non-Conductor) | Copper | Steel |
| Contacts | Copper, copper alloys, copper/tungsten | Silver laminates, silver/molybdenum carbide |
| Brushes, Carbon | Copper/graphite | Silver/graphite |
| Floodlight Lens Ring Clamp | Brass | Steel |
| Boxes, Conduit | Brass, bronze | Coated steel |
| Boxes, Outlet Fittings | Brass, bronze | Coated steel |
| Conduit and Cable Fittings | Brass, bronze | Painted steel |
| Tubing, Metallic | Brass, bronze | Coated steel |
| Bearings, Motor | Bronze or babbitt | Iron powder, silver lead |
| Telegraph-Printer Small Parts | Alloy steel | Carbon steel |
| Conduit, Rigid | Galvanized steel | Blackened steel |
| Pole Line Insulator Pins, Cross Arm Braces | Galvanized steel | Black-copper-bearing steel |
| Furnace Elements | Nickel-chromium, nickel-chromium-iron | Silicon carbide |
| Thermostat Elements | Nickel-steel, brass | Liquid expansion devices |
| Thermocouples | Chromium, Alumel | Platinum, platinum-rhodium |
| Solders, Dip | 60 lead, 40% tin | 90 lead, 10% tin |
| Solder, Electrical (Heavy) | Pure Tin | Silver brazing |

# How to Overcome Materials Shortages

| Product and Part | Scarce Material | Alternate |
|---|---|---|
| **BUSINESS MACHINES** | | |
| Outer Casing or Covers | Aluminum stamping or casting | Magnesium casting, reinforced plastics, steel plus coating |
| Machine Base | Aluminum casting | Gray or nodular iron casting |
| Bearings | Porous bronze, leaded Naval brass | Porous iron powder |
| Trim | Aluminum extrusions | Plastics |
| Flat Springs | Beryllium copper, phosphor bronze | Spring steel (1070) plus surface treatment |
| Contacts | Tungsten-iron alloy | Silver plated steel |
| Plated Internal Parts | Cadmium plating | Zinc plating |
| Plated External Parts | Nickel plating | Zinc plating |
| Rivet Studs | 4620 steel | 8620 steel |
| Miscellaneous Small Stampings | 1050 steel | 1010 steel |
| **REFRIGERATORS** | | |
| Cooling Coils | Copper, bronze | Coated steel |
| Shelves | Stainless steel | Porcelain enameled steel |
| Compartment Doors | Aluminum | Enameled steel |
| Ice-Cube Trays | Aluminum | Enameled steel |
| Evaporators | Brass, stainless steel | Porcelain enameled steel |
| Handles, Hinges | Stainless steel, zinc or aluminum die castings, chromium plate | Enameled steel, plastics |
| Inner Door Liners | Porcelain enameled steel | High pressure plastic laminates |
| **STOVES AND RANGES** | | |
| Oven Liners | Aluminum, stainless steel | Porcelain enameled stampings |
| Cooking Well | Aluminum | Enameled steel |
| Oven Vent | Brass, zinc die casting | Enameled or japanned steel, ceramics |
| Door Handles | Aluminum and zinc die castings, plate, stainless steel | Steel plus organic finish, plastics |
| Broilers | Aluminum, stainless steel, nickel plate | Porcelain enameled steel stamping |
| Oven Racks | Nickel alloy, stainless | Steel plus surface treatment or coating |
| Burners, Burner Heads | Aluminum casting | Cast iron, plain or enameled |
| Gas Range Connections | Copper alloys | Steel, cast iron |
| Trim | Brass, aluminum, stainless steel | Steel plus a finish |
| Hoods | Galvanized steel, stainless steel | Painted steel, plywood |
| **WASHING MACHINES** | | |
| Wringer Parts | Aluminum and zinc | Steel, cast iron |
| Tubs | Aluminum, stainless steel | Reinforced plastics, porcelain enameled steel |
| Drain Board | Aluminum, zinc | Steel stamping plus coating |
| Agitator | Aluminum, zinc | Plastic, assembled steel plus coating |
| Handles | Aluminum, zinc | Cast iron |
| **VACUUM CLEANERS** | | |
| Extension Tubes | Aluminum | Steel |
| Dusting Brush | Aluminum, rubber | Plastics |
| Handle | Aluminum | Plastic |

| Product and Part | Scarce Material | Alternate |
|---|---|---|
| **VACUUM CLEANERS —(Continued)** | | |
| Fan Housing | Aluminum, zinc | Cast iron, magnesium |
| Finishes | Nickel or chromium or cadmium plate | Zinc plate, organic finishes |
| **TOASTERS** | | |
| External Shell | Nickel plate | Zinc plate |
| Chassis | Steel | Glass, ceramics |
| Reflector Plates | Aluminum, nickel plate | Plated steel, thinner nickel plate |
| Heating Elements | Nickel alloys | Low nickel or iron-base alloys |
| **RADIOS AND TELEVISION** | | |
| Antenna Masts | Aluminum | Coated steel |
| Lead-in Wire | Copper | Reduction in size of wire |
| Mounting Hardware | Aluminum | Coated steel |
| Receiving Tubes | Nickel | Carbonized nickel-plated steel, aluminum clad steel |
| Stem Leads in Picture Tube | Nickel | Nickel-plated iron wire |
| Exhaust Tubulation -Picture Tube | Copper | Glass |
| Envelope-Picture Tube | Chromium steel | Glass |
| Frame Assembly-Picture Tube | Aluminum straps | Fabric straps |
| Solder | 40% tin | 20% tin |
| Hardware | Brass | Steel |
| Beam Bender (Magnet) | Alnico 5 | Alnico 3 (no cobalt) |
| Chassis | Aluminum, steel | Magnesium, fiberous sheet |
| **DOMESTIC HEATING SYSTEMS** | | |
| Casings | Galvanized steel, steel | Fiberous sheet, plywood |
| Flues, Ducts | Galvanized steel | Fiberous sheet, plywood |
| Sticker Parts | Aluminum and zinc die castings | Cast iron |
| Hot Water Tanks | Copper alloys, galvanized steel, nickel alloys | Glass lined steel |
| Pipes | Copper alloys | Cast iron |
| **OTHER UTILITIES** | | |
| Sinks | Stainless steel, nickel alloys | Porcelain enameled steel, plastic laminates |
| Kitchen Cabinets | Steel | Wood |
| Cooking Utensils | Aluminum, copper alloys, chromium plate | Porcelain enameled steel, glass, cast iron |
| Furniture | Aluminum, brass, chromium and nickel plate, stainless steel, steel | Wood, steel plus coatings, magnesium |
| Lamps | Aluminum, copper alloys, chromium plate, stainless steel | Wood, glass, porcelain |
| Electric Fan Blades | Aluminum, chromium plate | Steel plus coating, plastic |
| Electric Fan Base | Aluminum and zinc die casting | Cast iron plus coating, wood |
| Roofing Gutters | Copper, aluminum, galvanized steel | Wood |

# Materials Engineering File Facts

NUMBER 211
July, 1951



## Typical Properties of Vanadium Spring Steels

### CHROMIUM-VANADIUM STEELS

**Composition, %**

| | C | Mn | Si | Cr | V |
|---|---|---|---|---|---|
| AISI 6150 | 0.48–0.53 | 0.70–0.90 | 0.20–0.35 | 0.80–1.10 | 0.15 min |
| AISI 6152 | 0.48–0.55 | 0.70–0.90 | 0.20–0.35 | 0.80–1.10 | 0.10 min |
| AISI 6160 | 0.55–0.65 | 0.60–0.90 | 0.15–0.30 | 0.80–1.10 | 0.15 min |

Chromium-vanadium compositions similar to the above are covered in the following specifications:
ASTM A 60 —Bars for springs
ASTM A 231—Steel spring wire
ASTM A 232—Steel valve spring quality wire
VCA 6D—Bars for railway elliptic springs
VCA 8C—Bars for springs

**Mechanical Properties**

Range of tensile properties:

| Yield Point, Psi | Ten. Str., Psi | Elong., % in 2 In. | Red. of Area, % | BHN |
|---|---|---|---|---|
| 165,000–210,000 | 175,000–230,000 | 14–10 | 45–30 | 360–460 |

Springs of this composition maintain their properties and dimensions at moderately elevated temperatures. At maximum fiber stresses up to 100,000 psi the full load is maintained without loss at temperatures as high as 400 F, although applications as high as 750 F are satisfactory where less severe loading conditions exist, or where the range of stress is low, or stress changes are infrequent.

For elliptic springs, mean static stresses as high as 105,000 or 110,000 psi are used.

For helical springs, maximum fiber stresses as high as 100,000 or 110,000 psi are used.

Typical properties in torsion:

| Yield Point, Psi | Ult. Str., Psi | BHN | Angle of Twist at Rupture, Deg. 9-in. Gage Length |
|---|---|---|---|
| 113,000 | 193,000 | 404 | 1,160 |

Typical torsional endurance limit (total stress range):

| Zero Mean Stress, Psi | 77,000 Mean Stress, Psi |
|---|---|
| 126,000 | 110,000 |

**Heat Treatment**

Oil quench: 1525 to 1625 F
Temper: 850 to 1050 F
Also used in cold drawn and stress-relieved (450 to 650 F) condition.
Sometimes: Cold drawn, oil quenched, tempered, coiled, stress-relieved (450 to 650 F).

**Uses**

High quality suspension springs for railroads, automobiles, trucks, busses, tractors—usually elliptic but sometimes helical or torsion bar. Internal combustion engine valve springs. Steam valve springs.

Helical springs for crushers, presses and reciprocating mechanisms for other machinery.

Belleville disk springs.

General purpose, small and medium size springs from either flat or round bars, flat or square wire for a variety of applications.

Springs of larger cross-section, such as locomotive elliptic springs or large helical springs are made of the higher carbon compositions.

### SILICON-VANADIUM STEEL
### (VCA Specification 4D)

**Composition, %**

| C | Mn | Si | V |
|---|---|---|---|
| 0.88–0.98 | 0.45–0.65 | 0.50–0.75 | 0.15 min |

**Mechanical Properties**

Range of tensile properties:

| Yield Point, Psi | Ten. Str., Psi | Elong., % in 2 In. | Red. of Area, % | BHN |
|---|---|---|---|---|
| 175,000–200,000 | 195,000–220,000 | 10–8 | 30–20 | 380–444 |

This steel possesses free-scaling qualities which are advantageous to surface of bars under the proper conditions. Extensive testing has indicated unusually high fatigue strength in torsion and in bending.

**Heat Treatment**

Oil quench: 1580 to 1650 F
Temper: 850 to 1050 F
Also used as cold drawn wire and stress-relieved (450 to 650 F) following the coiling operation (smaller sizes).

**Uses**

Large helical springs for trucks of railway cars and locomotives (½ in. to 1½-in. bar size).
Smaller springs of cold drawn wire.

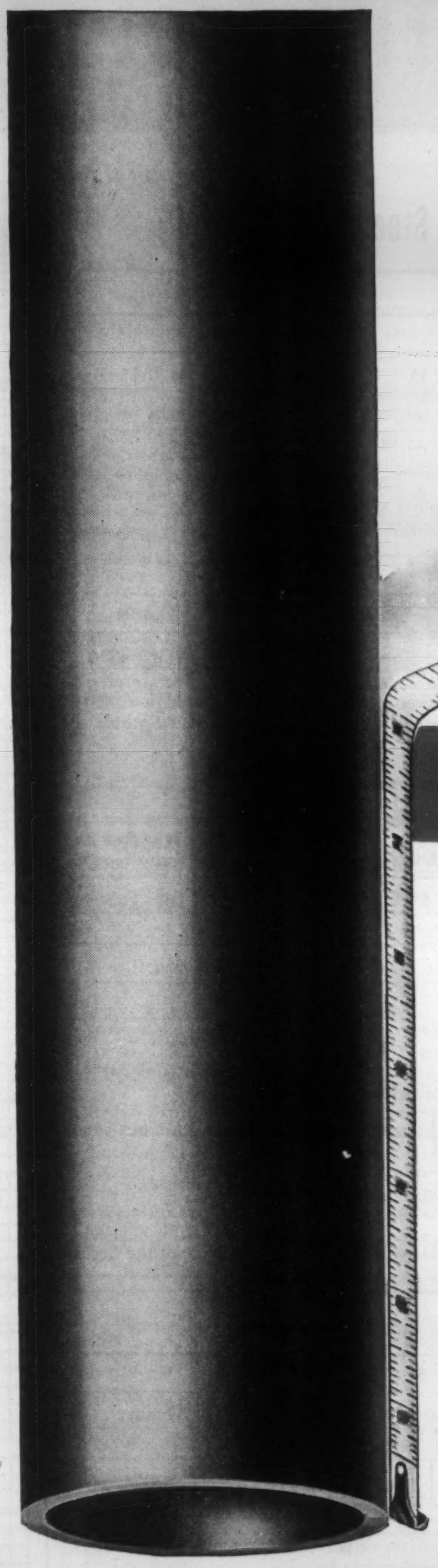
### CARBON-VANADIUM STEEL

**Composition, %**

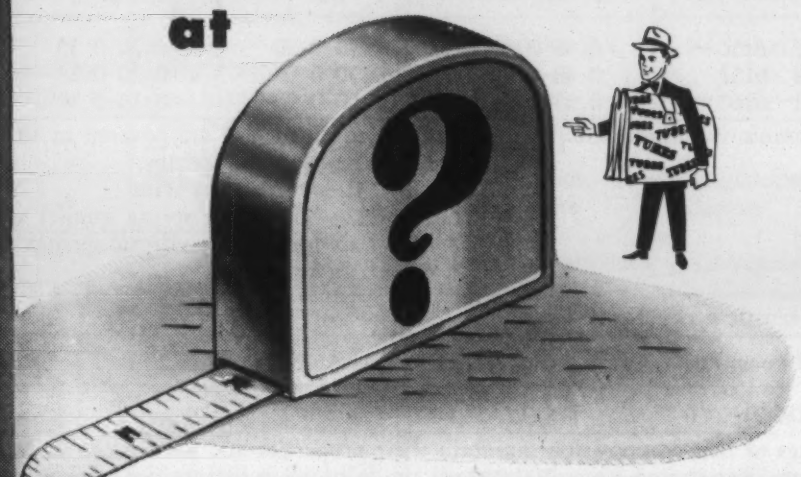
| C | Mn | Si | V |
|---|---|---|---|
| 0.65–0.75 | 0.65–1.05 | 0.30–0.40 | 0.05–0.10 |

(0.30–0.45 chromium sometimes added, with manganese at lower side of above range.)

*(Continued on page 115)*



**Let's take a Closer Look at**




# tubing length

Here are the different kinds of length you can specify for all B&W Mechanical Tubing. Remember, as you go *down* the following list, the *price* generally goes down.

CUT LENGTH: close plus tolerance on a specified length; base price on lengths 10-24 feet . . . cut-lengths over 24′ and under 10′ cost more.

MULTIPLE LENGTH: suitable for cutting into smaller pieces of a specified length with negligible loss; up to 3½% saving in price.

SELECTED RANDOM LENGTH: specified minimum and maximum; up to 5% saving in price.

RANDOM LENGTH: no specified minimum or maximum; 5% saving in price.

Consider your product, production set-up, material handling, and stores facilities. Then fit your length-specification to the job, for initial savings and optimum scrap loss. New Bulletin TB-335 gives details on length and other descriptive terms, a clear understanding of which will simplify and facilitate ordering.

**THE BABCOCK & WILCOX TUBE COMPANY**

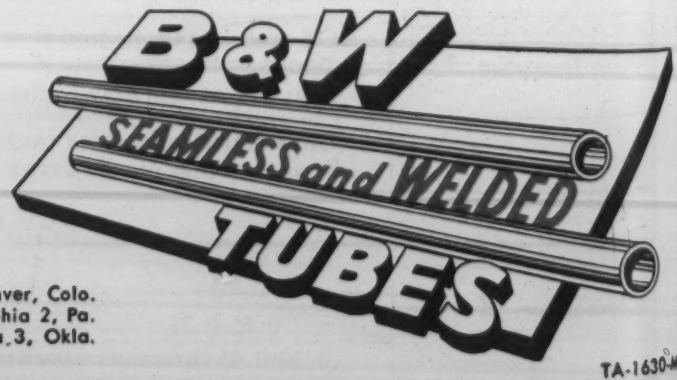
*Executive Offices:* Beaver Falls, Pa.

*General Offices & Plants*

Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing

Alliance, Ohio—Welded Carbon Steel Tubing

*Sales Offices:* Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. • Cleveland 14, Ohio • Denver, Colo. Detroit 26, Mich. • Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y. • Philadelphia 2, Pa. St. Louis 1, Mo. • San Francisco 3, Calif. • Syracuse 2, N. Y. • Toronto, Ontario • Tulsa 3, Okla.




TA-1630-M

# Materials Engineering File Facts

NUMBER 211 (Continued)

## TYPICAL PROPERTIES OF VANADIUM SPRING STEELS

### CARBON-VANADIUM STEEL—(Continued)

**Mechanical Properties**

Typical tensile properties (1550 F oil quench plus 900 F air cool):

| Yield Point, Psi | Ten. Str., Psi | Elong., % in 2 In. | Red. of Area, % | Izod Impact, Ft–Lb | BHN |
|---|---|---|---|---|---|
| 186,400 | 199,400 | 12.0 | 39.3 | 15 | 386 |
| 184,400 | 199,800 | 11.0 | 37.7 | 16 | 399 |

**Heat Treatment**

Oil quench: 1525 to 1625 F
Temper: 750 to 1050 F

**Uses**

Helical and elliptic springs up to about 1 in. in section, for automobile and railway applications. Small springs for use at moderately elevated temperatures.

### CHROMIUM-MOLYBDENUM-VANADIUM STEEL (VCA Specification 18A)

**Composition, %**

| C | Mn | Si | Cr | Mo | V |
|---|---|---|---|---|---|
| 0.35–0.40 | 0.40–0.60 | 0.20–0.35 | 2.25–2.75 | 0.40–0.60 | 0.22–0.30 |

**Mechanical Properties**

Range of tensile properties:

| Yield Point, Psi | Ten. Str., Psi | Elong., % in 2 In. | Red. of Area, % | Izod Impact, Ft–Lb | BHN |
|---|---|---|---|---|---|
| 175,000–215,000 | 180,000–220,000 | 12–9 | 50–40 | 21–14 | 377–446 |

Springs of this composition maintain their properties and dimensions at moderately elevated temperatures. They are suitable for use above the range in which chromium-vanadium steel springs are applicable. There are applications at temperatures as high as 900 F; of course, the range of loading and the frequency of load changes will affect the continued performance of this steel at high temperatures.

**Heat Treatment**

Oil quench: 1575 to 1625 F
Temper: 900 to 1150 F

**Uses**

Coil springs for moderately high temperatures in automotive applications such as special clutch springs, valve springs, etc.; also as locomotive piston rod packing springs and by-pass valve springs.

### CHROMIUM-TUNGSTEN-VANADIUM STEEL

**Composition, %**

| C | Mn | Si | Cr | W | V |
|---|---|---|---|---|---|
| 0.40–0.65 | 0.20–0.35 | 0.20–0.35 | 1.00–2.00 | 1.50–2.50 | 0.20–0.40 |

**Mechanical Properties**

Resistance to softening at elevated temperatures.
High creep resistance.

**Heat Treatment**

Oil quench: 1600 to 1650 F
Temper: 850 to 1150 F

**Uses**

For springs which are exposed to elevated temperatures during service.

### SILICON-MOLYBDENUM-VANADIUM STEEL

**Composition, %**

| C | Mn | Si | Mo | V |
|---|---|---|---|---|
| 0.55–0.65 | 0.80–1.10 | 1.80–2.10 | 0.45–0.60 | 0.30–0.40 |

**Mechanical Properties**

Resistance to softening at elevated temperatures.
High creep resistance.

**Heat Treatment**

Oil quench: 1600 to 1625 F
Temper: 850 to 1150 F

**Uses**

For springs which are exposed to elevated temperatures during service.

### MANGANESE-SILICON-MOLYBDENUM-VANADIUM STEEL

**Composition, %**

| C | Mn | Si | Mo | V |
|---|---|---|---|---|
| 0.50–0.60 | 1.00–1.25 | 1.80–2.10 | 1.20–1.40 | 0.30–0.40 |

**Mechanical Properties**

Resistance to softening at elevated temperatures.
High creep resistance.

**Heat Treatment**

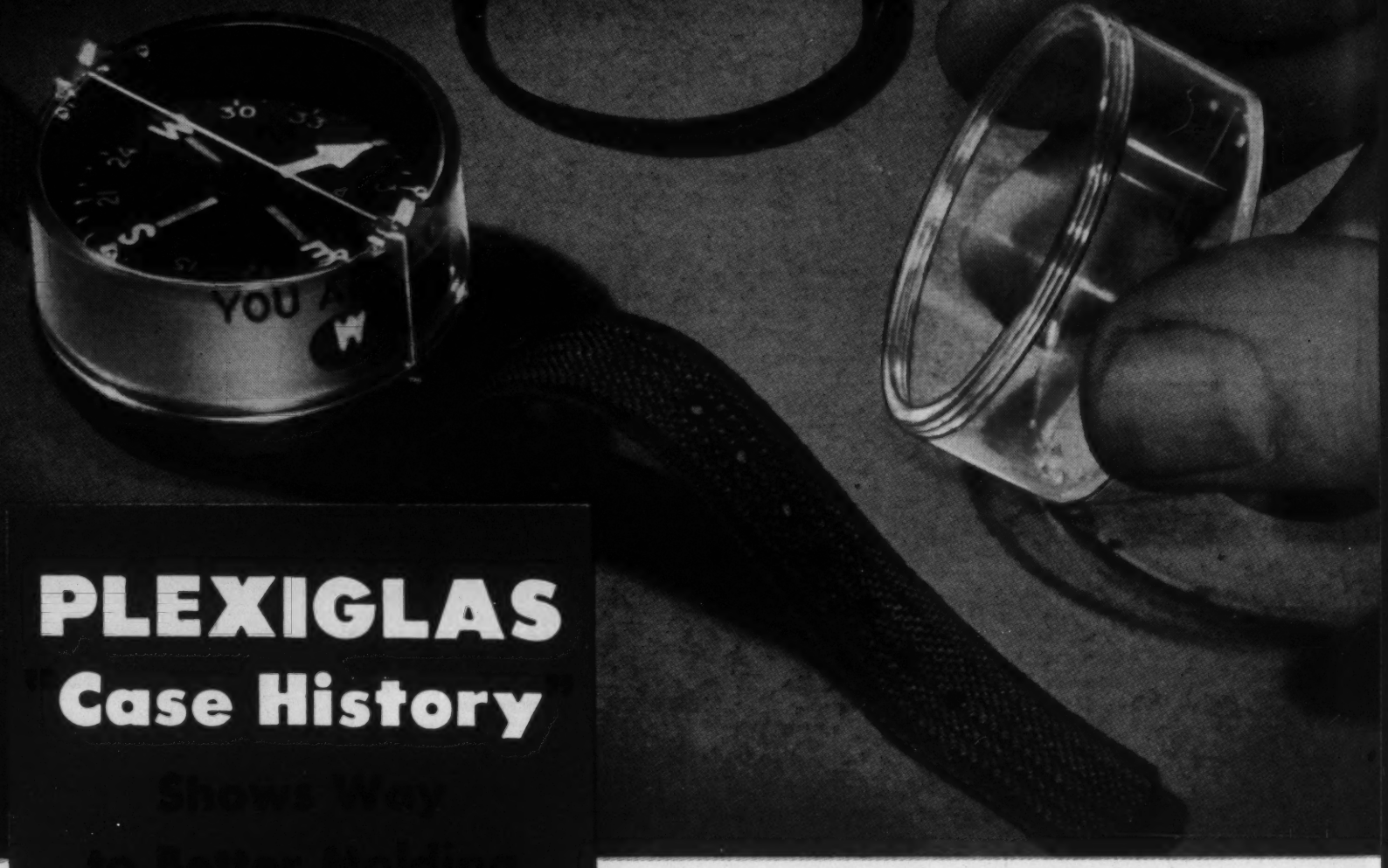
Oil quench: 1625 to 1650 F
Temper: 850 to 1150 F

**Uses**

For springs which are exposed to elevated temperatures during service.

*Adapted from data supplied by Vanadium Corp. of America.*

**PLEXIGLAS injection-Molded Cover**—Molded of PLEXIGLAS V-100 Molding Powder, this wrist compass cover is 3.75" in diameter, has .060" walls. Threads, lubber line, sighting notches, and tiny tips on inside top surface, all are molded-in. Tips hold an aluminum wall shield in place, in which an aperture is cut for the "You Are Looking . . ." feature. Tolerances: For the thread diameter, ± .004"; lubber line, maximum .010" deep and .016" wide; tips, .012" to .015" clearance from wall. Compass manufactured by United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa. PLEXIGLAS covers molded by W. Howard Stagg Plastics Engineering Company, Philadelphia, Pa.



# PLEXIGLAS Case History

## Shows Way to Better Molding

This transparent cover for an Air Force wrist compass *could* have been a headache to its molder. Specifications required optical clarity, outdoor durability, resistance to heat and impact, and molding to *precision* tolerances. The selection of PLEXIGLAS V-100 for the job was a logical solution to this combination of problems.

PLEXIGLAS acrylic plastic molding powders can solve *your* problems, too. Their excellent flow characteristics permit satisfactory molding over a wide range of temperatures and pressures. From small parts to large sections molders report good production rates.

PLEXIGLAS V-100 is only one of the Rohm & Haas "V", "VM", and "VS" formulations now going into defense applications. Headlight lenses for amphibious military vehicles, blackout lenses, transparent containers for medical supplies, barracks windows, aircraft radio antenna housings, are being molded of PLEXIGLAS Molding Powders. We'll be glad to send you full details of these acrylic plastic powders.

CHEMICALS FOR INDUSTRY

**ROHM & HAAS COMPANY**

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

*Representatives in principal foreign countries*

**A steadily increasing percentage of PLEXIGLAS production, now at record levels, is required for the defense mobilization program. The supply available for civilian applications is limited.**

*PLEXIGLAS is a trade-mark, Reg. U.S. Pat. Off. and in principal foreign countries.*

Canadian Distributor:—*Crystal Glass & Plastics, Ltd.*
*54 Duke Street, Toronto, Ontario, Canada*

# New Materials and Equipment

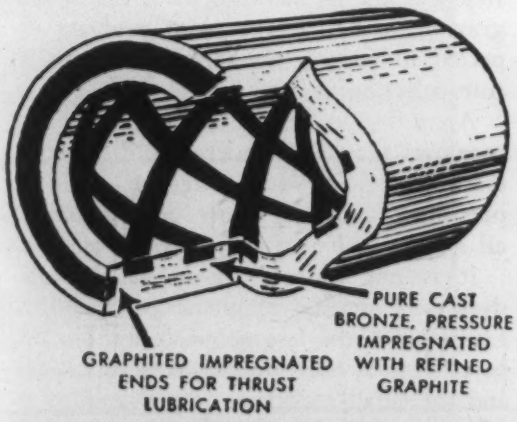
## Materials & Parts

### Self-Lubricated Bushings and Bearings

A new line of graphited oil-less bronze bearings and bushings have been introduced by *Bronze Bearings, Inc.,* Cranford, N. J.

Designated Gopi, the new parts are claimed to possess the following advantages:

1. No lubrication during the life of the bearing is required.
2. Only pure graphite is used with a specially developed and tenacious binder.
3. The graphite composition is applied under pressure by hydraulic or other adequate means, then baked at high temperature for permanence.
4. They are impregnated in such a manner as to secure complete surface




*Here is illustrated the manner of impregnating pure bronze bearings with highly refined graphite.*

coverage, giving the working effect of a metal saturated with lubricant.

According to the manufacturer, these bearings, thrust-washers and bushings are widely adaptable and can be made in almost any size. They can be installed in remote and inaccessible locations: where fluid lubricants would contaminate work in process; where temperatures would oxidize oil; where oil films would rupture under many static loads; where bearings are immersed in liquids; or where machines must be made as immune as possible to carelessness and neglect.

### Graphite Ground Anode

Recently announced by *National Carbon Co.,* a division of *Union Carbide and Carbon Corp.,* 30 E. 42nd St., New York 17, the new size 3- by 60-in. graphite ground anode is said to provide longer life because of more pounds of graphite per unit of exposed surface.

Recommended for the cathodic protection of pipe lines, tank farms, refinery equipment, ships, electric sub-stations and all sorts of underground and underwater metal structures, the anode is claimed to be rugged enough to withstand normal installation bumps without damage.

Furnished complete with 36-in. long insulated No. 8 weatherproof cables, the anodes permit ground installation savings by their shorter lengths, which require less holes to be bored.

**CONTENTS**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### Insulated Wire and Cables

*Tensolite Insulated Wire Co., Inc.,* Tarrytown, N. Y., has announced the production of new tensulated miniature wires, each consisting of four strands of No. 40 copper wire so that 1400 strands occupy an area of ¼ by ⅝ in.

This new degree of miniaturization was made possible by tensulation, a new process which is said to make it practical to provide low voltage hookup wires, shielded lead wires and small flexible cables that are made to fit individual needs.

*These wires are so small that 350 of them are said to be able to pass through half a paper clip.*

Production of tensulated conductors is devoted principally to the lighter and more flexible stranded conductors composed of tinsel or finer gage wires.

### High Strength Aluminum Alloy

A new aluminum alloy, which is said to be 10% stronger than the highest strength aluminum alloy now in use, has been developed by the *Aluminum Co. of America,* 801 Gulf Building, Pittsburgh 19.

Presently being made available to plane builders and controlled production use,

# New Materials and Equipment
(CONTINUED)

XA78S is expected to permit lighter airframe construction since less metal will be needed to meet every structural strength.

This particular metallurgical advancement, the result of several years of research, was accomplished by modifying the same alloy constituents that were combined to produce Alloy 75S, which was designed to meet aircraft needs in 1944. Although the main alloy composition is the same for both 75S and XA78S in that they are of the aluminum-zinc-copper-magnesium family, XA78S is claimed to be approximately 10% higher in tensile and yield strengths with the same elongation and fatigue properties. Limited tests indicate, however, that the increase in mechanical properties will involve some sacrifice in workability.

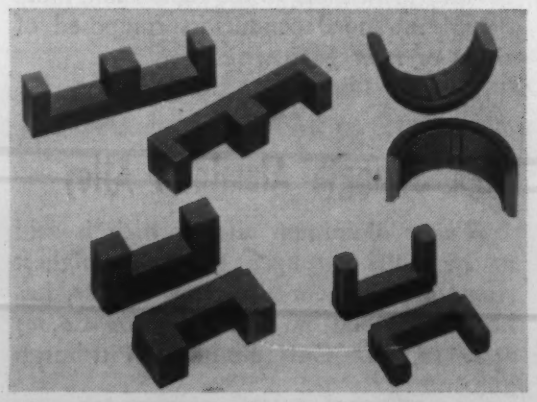
For the present, the manufacturer states that the new alloy will be confined to the production of sheet and plate—in both bare and alclad forms—and extrusions.

## High Permeability Ceramic

*D. M. Steward Manufacturing Co.*, Chattanooga, has announced the production of Lavite Ferrites, a compound of a complex crystalline structure formed by special treatment of selected metallic oxides.

According to the manufacturer, these ferrites combine high permeability and low electrical losses, permitting the reduction of both size and weight of components in electrical circuits; and because of their unusual variation in composition, application possibilities are unlimited. It is said to be possible to obtain such specific electrical properties as high saturation, higher permeabilities, higher Q and FM frequencies, low temperature coefficient of permeability, and replacement of conventional magnetic materials at power frequencies.

Recommended uses for the ferrites are in television circuits (horizontal output transformer cores, permeability tuning cores and deflection yokes), antenna cores for radio receivers, toroidal coil cores, electronic computers, high frequency ferrites with printed circuits 1-200 mc and high saturation ferrites (5000 gauss).



*These ferrites can be used in IF transformers for TV and frequency modulation.*

## Electrical Steel

A new, thin electirical steel, said to have excellent workability, designed for use in wound-type transformers and reactors which operate at 400 cycles, has been developed by *Armco Steel Corp.*, Middletown, Ohio.

Tran-Cor T-O-S is an iron-silicon alloy with a high degree of orientation obtained by special processing and test-selection for high permeability requirements. It can be operated at very high inductions, 20% higher than any nickel-iron alloy.

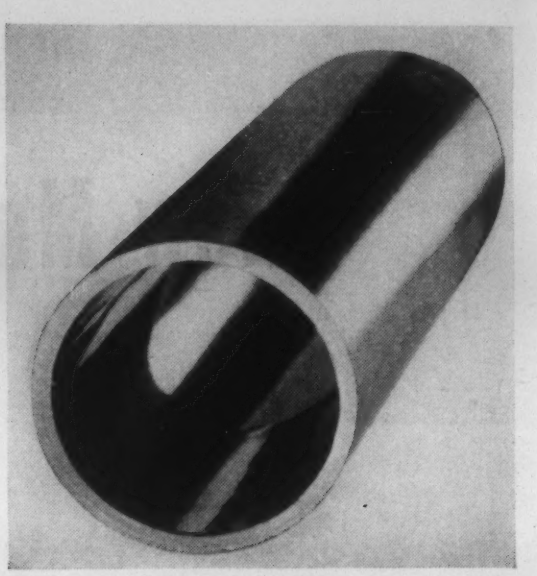
According to the manufacturer, the new steel not only has a marked advantage in the low exciting current required at inductions over 16 kilogausses, but also a low core loss. Its minimum permeability at 18 kilogausses is 1800. Other properties are: a density of 7.65 grams per cu cm, a volume resistivity of 47 microhm-cm, and a lamination factor of 95% solid.

Supplied only in 4-mil thicknesses and in 12⅜-in. wide coils, the new steel is surface treated on both sides by a special chemical and thermal processing to insure low interlaminar energy losses.

## Cylinder-Finish Tubing

Especially suited for use as hydraulic cylinders, shock absorbers and other applications where pressure is to be converted into mechanical movement, the new line of tubing offered by *Tube Reducing Corp.*, Wallington, N. J., is available in bores ranging from 1½ to 6 in., depending on wall thickness.

Because compression sizing cold-works the metal, the new tubing is said to have better mechanical properties than hot-rolled or cold-drawn standard varieties. Mechanical properties of the original tubing are greatly improved, according to the manufacturer, the exact extent depending upon the steel analysis and the amount of cold working required in sizing.



*For use with metal piston rings, this cylinder-finish tubing requires no boring, but only a slight honing operation.*

Surfaces of the tubing are claimed to be so smooth that they need no machining for use with leather or other soft packing, such as is used for cup pistons.

# Coatings & Finishes

## Iron Core Dyes

*G. A. & F. Carbonyl Iron Powders*, New York, has announced the successful development of a group of dyestuffs that can be incorporated with the Carbonyl iron powder in core production to identify various types of cores for special uses. The new dyes are expected to eliminate the time-consuming marking of cores by engraving, embossing or paint, and are expected to reduce the hazard of errors in core selection.

According to the manufacturer, the new core dyes are stable under humidity, temperature, and a wide range of molding pressures; and they show their colors in all shapes and over long periods of time.

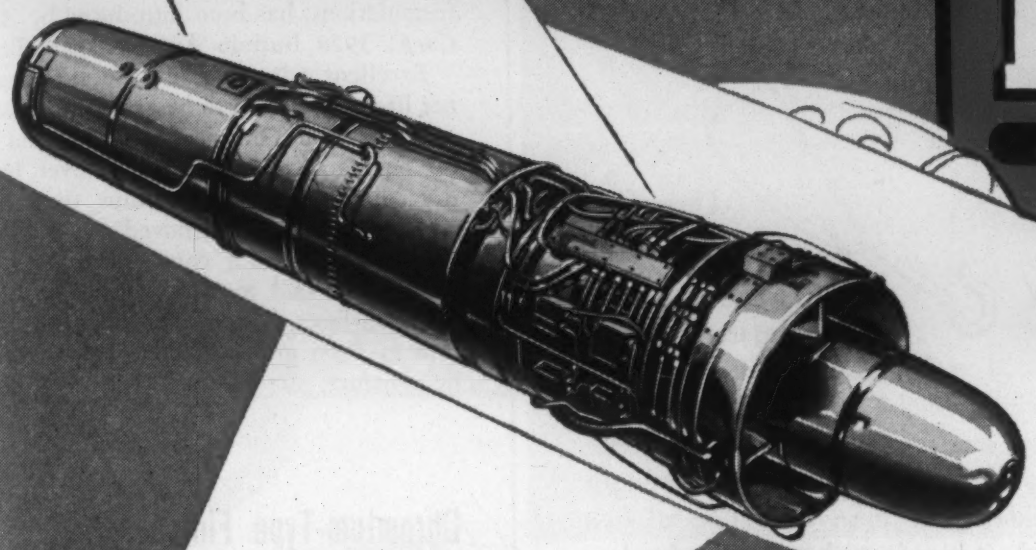
It is not claimed, however, that the dyes will increase magnetic permeability. Less iron means less permeability, but the percentage of the strong dyes is very small and the small reduction of permeability is offset by the sure identification of cores, saving time, and the simplification of assembly procedure in the production of electronic equipment.

## Rust Inhibitors

A new oil-soluble rust inhibitor, L-1673, which is said to protect metals from corrosion 10 to 15 times longer than previous

Another First for...

N-A-X
ALLOY STEELS



*The use of N-A-X ALLOY STEEL in Aircraft Gas Turbines saves up to 50 per cent of critical Stainless Steel.*

## *Conservation is possible – without sacrifice with use of N-A-X ALLOY STEELS*

With the demand for greatly increased quantities of the critical and strategic Stainless Steels used in Jet Engines intensified by the acceleration of the building program, the Air Force requested the producers of these engines to seek *suitable* material with less critical alloy content to replace the Stainless Steel for certain moderate temperature application in these aircraft gas turbines.

The steel selected had to be of low-alloy content with high strength and good welding characteristics. Ordinary low carbon steel did not meet the requirements because of its low tensile properties and the fact that it could not be satisfactorily welded by the inert arc process, which is widely used in aircraft gas turbine manufacture.

The data available from tests made on several weldable low-alloy, high-strength steels indicated that N-A-X ALLOY STEEL was the most satisfactory of the group — *its selection followed.* Unlike other possible substitutes, N-A-X ALLOY STEEL has good low temperature impact values, maintains its higher strength and is not subject to temper brittleness in the wide operating temperature range required of the steel for this purpose — from a low of −70°F. to +800°F.

The use of N-A-X ALLOY STEEL for this application has cut the amount of Stainless Steel required in half. This is of considerable importance to the Air Force.

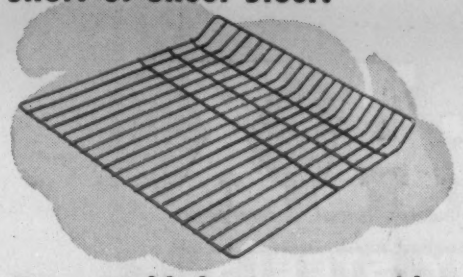
**GREAT LAKES STEEL CORPORATION**

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

# Problems Like These?

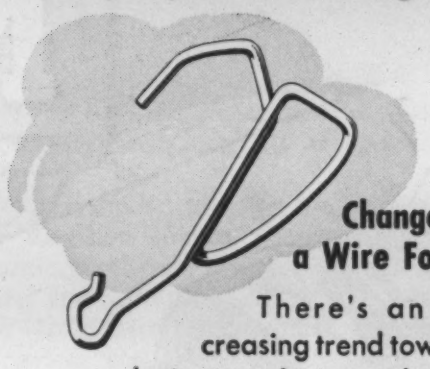
**Short of Sheet Steel?**



**Try a Welded Wire Assembly!**

This Titchener-made tray for an ice cube machine replaces a stainless sheet steel piece. *Advantages: A better product.* Water now drains through — no longer overflows as it did with original stamping. *Lower cost.* Tooling was negligible, compared to expensive die required for the stamping. *Immediate availability.*

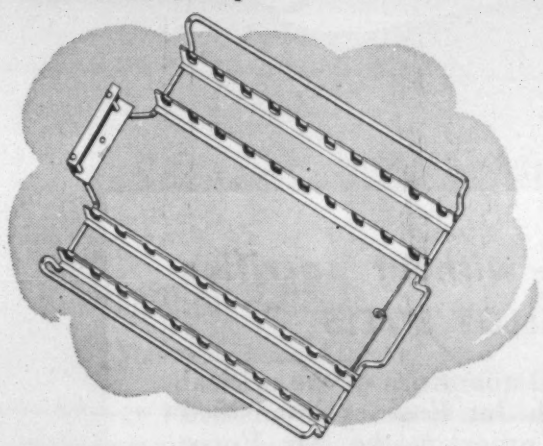
**Using Expensive Castings?**



**Change to a Wire Form!**

There's an increasing trend toward substitution of wire and wire-strip assemblies for castings, forgings and machined parts. This solder pot holder is an example. Stronger and lighter than a casting of like size, it is safe, unbreakable, far less costly.

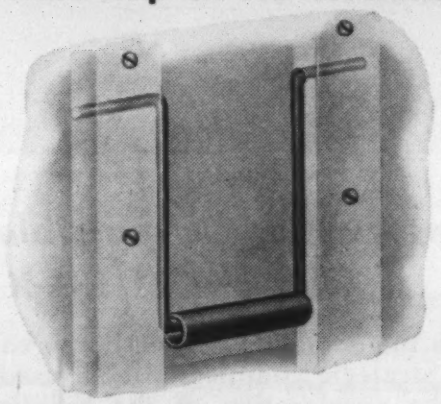
**Want Fast, Expert Production?**



**Wire and Strip Assemblies— On Time!**

Mass production of complicated designs is a Titchener specialty. This heating element rack requires 49 punched holes, 23 bends in heavy wire, 12 bends in strip steel and 22 spot welds — all punched, formed, assembled, welded in surprisingly fast time . . . and at minimum cost.

**Need Help on Sub-Contracts?**



**Come to Wire Goods Headquarters!**

For 65 years and through two World Wars, Titchener has worked closely with prime contractors in meeting government specifications on such parts as this ammunition box handle. Our experience with every conceivable type of wire and strip part can lick just about any problem you bring us.

**TELL IT TO TITCHENER!**

**If your problem involves wire forms, welded-wire assemblies or wire-and-strip-steel items — Tell it to Titchener. Titchener offers you . . .**

**1 — Design Assistance**
**2 — Sample Making**
**3 — Tool & Jig Making**
**4 — High Volume Production**
**5 — Plating & Finishing**
**6 — Prompt Delivery**

**Send us your prints — or describe your requirements in a letter. No charge for our suggestions.**

**E. H. TITCHENER & CO.**
**104 Clinton St. Binghamton, N. Y.**


# New Materials and Equipment

formulations, has been introduced by *Alox Corp.*, 3928 Buffalo Ave., Niagara Falls.

Excellent salt spray and humidity cabinet life are claimed to be experienced with oils containing the new additive, and its oil blends have an advantage over hard, dry corrosion preventive films since they are far more easily removed.

Polar compounds contained in the inhibitor are said to adhere tenaciously to metal surfaces, bonding the oil to the surface to form a dense barrier to corrosion by moisture, salt water and corrosive gases.

## Chromium-Type Finishes

*United Chromium, Inc.*, 100 E. 42nd St., New York 17, has announced a new line of finishes which do not require use of either copper or nickel.

Unichrome Clear Dip and Unichrome Baking Synthetic B-115 provide a finish similar to that of chromium plate and are said to offer protection against the rusting of zinc. In the process, the part is zinc plated to a thickness of 0.0002 to 0.0005 in., depending upon the application. It is then treated with the clear dip, dried and given a spray of Clear Baking Synthetic B-115.

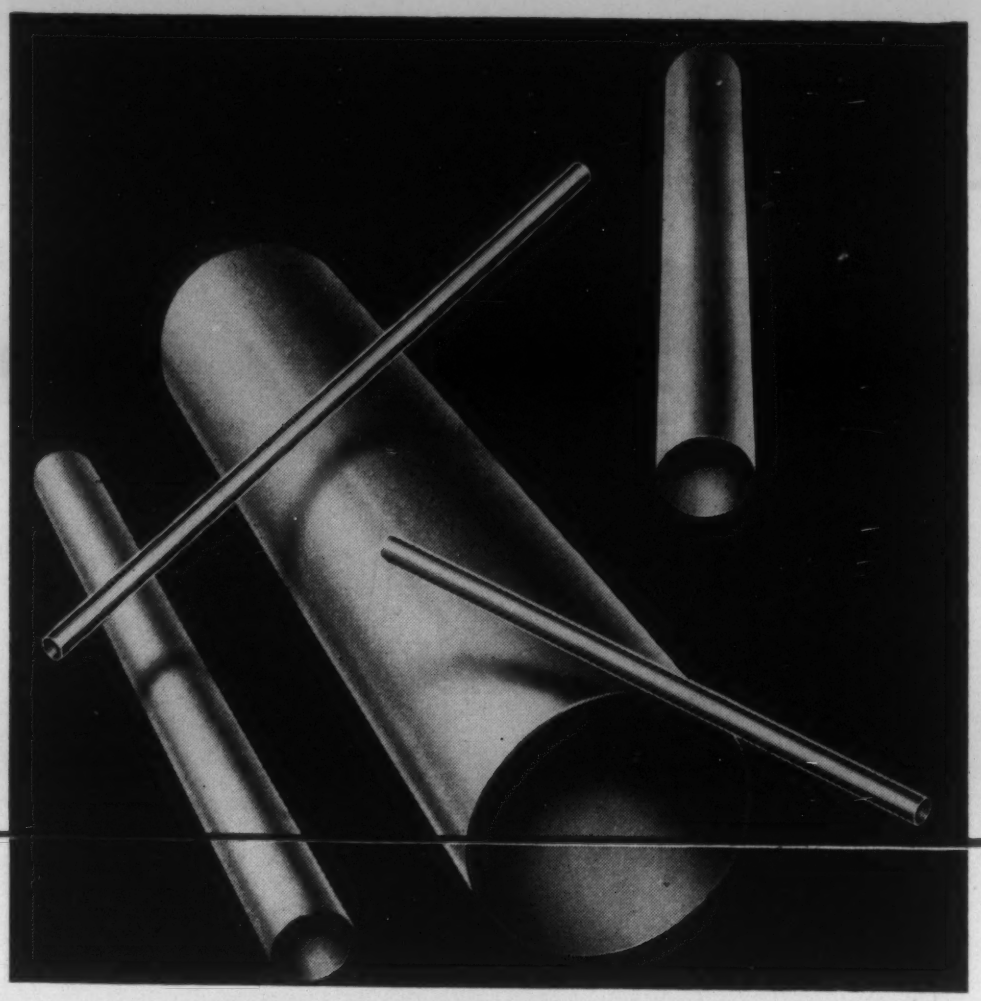
Unichrome Dip Compounds 1060 and 1070 are also offered by United Chromium to produce corrosion resistant, chromate-type conversion coatings that are black or olive drab in color. These compounds are claimed to yield lustrous finishes that meet the corrosion resistance requirement of most specifications for chromate-type conversion coatings on zinc. Finishes are produced on a metal conserving deposit of 0.0002 to 0.0005 in. of zinc, and the process is a simple dipping one, carried on at room temperature. In addition to these compounds, others are available for producing clear finishes on zinc plate and also yellow iridescent coatings on zinc plate or zinc die castings.

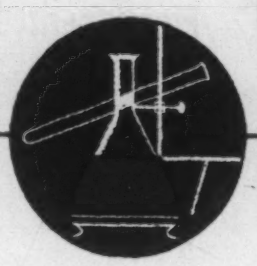
## Bronze Lacquer Finishes

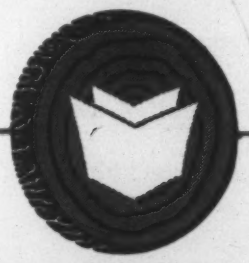
A new line of metallic bronze lacquer finishes which will be offered only to the industrial trade has been announced by *National Lacquer and Paint Co., Inc.*, 7415-39 S. Green St., Chicago 21.

Fifteen colors, which include various shades of old English, Antique, Statuary Gold, Copper, Brass, etc., are all designed to simulate closely the appearance of plated metal.

Formulation of these lacquers is said to

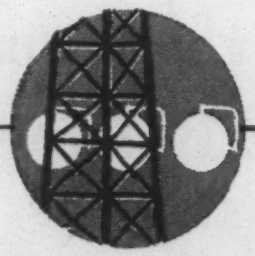






## where stainless steel tubing

## is required—



# TRY TRENTWELD

Stock lines in food, paper, and chemical plants; heat exchanger units in processing industries; cooling coils in breweries, beverage industry, dairies and dairy equipment . . . throughout all industry, wherever there's a stainless or high alloy tubing application, there you'll find TRENTWELD.

And it's to be expected! TRENTWELD is made in a *tube* mill by *tube* engineers who roll and weld stainless and high alloy tubing *exclusively*. Then too, TRENTWELD is available in a full range of sizes—⅛" to 36" in diameter. This coupled with Trent's convenient mid-continent location means prompt delivery of what you want . . . when you want it. If yours is a stainless or high alloy tubing requirement: Call on us. TRENT TUBE COMPANY, *Subsidiary of Crucible Steel Company of America*. General offices and plant: East Troy, Wisconsin; Sales offices in principal cities.

**TRENTWELD**

**STAINLESS STEEL TUBING**

## An Important Material for Designers

**GLASS**

**—and only GLASS provides all of these valuable properties:**

- **HEAT RESISTANCE**
- **COLORFUL BEAUTY**
- **HIGH STRENGTH**
- **LOW COST**
- **HARD, SMOOTH SURFACE**
- **PROOF AGAINST MOISTURE**
- **SANITARY, EASY TO CLEAN**
- **WON'T ROT, RUST, WARP, STAIN**

All of these properties you can translate into effective *sales* points, for they give greater beauty and utility to products employing glass.

Kopp specializes in the design and manufacture of glass components, precision-made to customers' specifications. We will be glad to discuss with you, the possibility of using Kopp glass in your products.

KOPP GLASS

**KOPP GLASS, Inc.**
**SWISSVALE, PA.**


# New Materials and Equipment

represent radical departure from earlier thinking. No dyes or bronze powders are used. Particle size is controlled by rigid selection of raw materials to give maximum luster and reflectivity, and complete dispersion of pigments is obtained through special processes.

An unusual feature claimed for the new finish is that casting of shadows has been totally eliminated. Color and reflectivity are always the same when viewed from any angle. The products are also said to be non-caking, non-jelling and relatively free from settling out difficulties. All colors are warranted to be light-fast and non-fading.

## Prepolymerized Furan Coating

A new B resin, a furan base coating, which is said to be superior in corrosion resistance to any other type of brush-on-coating, has been announced by *Carboline Co.*, 7603 Forsyth Blvd., St. Louis 5.

Advantages claimed for the new coating are:

1. It possesses flexibility without the use of a plasticizer; therefore embrittlement cannot occur as a result of the leaching out of a plasticizer.
2. It possesses a finely fused film as the result of polymerization.
3. B resin possesses the resistance of furan materials to nonoxidizing acids, solvents and alkalis, as well as resistance to oxidizing acids and bleaches.

The coating is applied by brush directly from the can. For application on steel, one coat of B resin primer, followed by three to seven coats of the finish, is recommended. No primer is required for use on wood, carbon, glass or Hycar rubber.

# Heating, Heat Treatment

## Induction Forge Heater

Featuring speed and flexibility, the new Ajax-Northrup induction forge heating equipment, offered by *Ajax Electrothermic Corp.*, Trenton 5, N. J., is said to automatically heat a wide range of billet sizes and shapes to a variety of pre-selected heating patterns.

Three pieces, each with a power range of from 50 to 1500 kw, 400/800-v, and 3000 cycles, are now in use heating steel

# YOU may telescope the distance from blueprint to sales

## ...by calling on your plastics molder's know-how

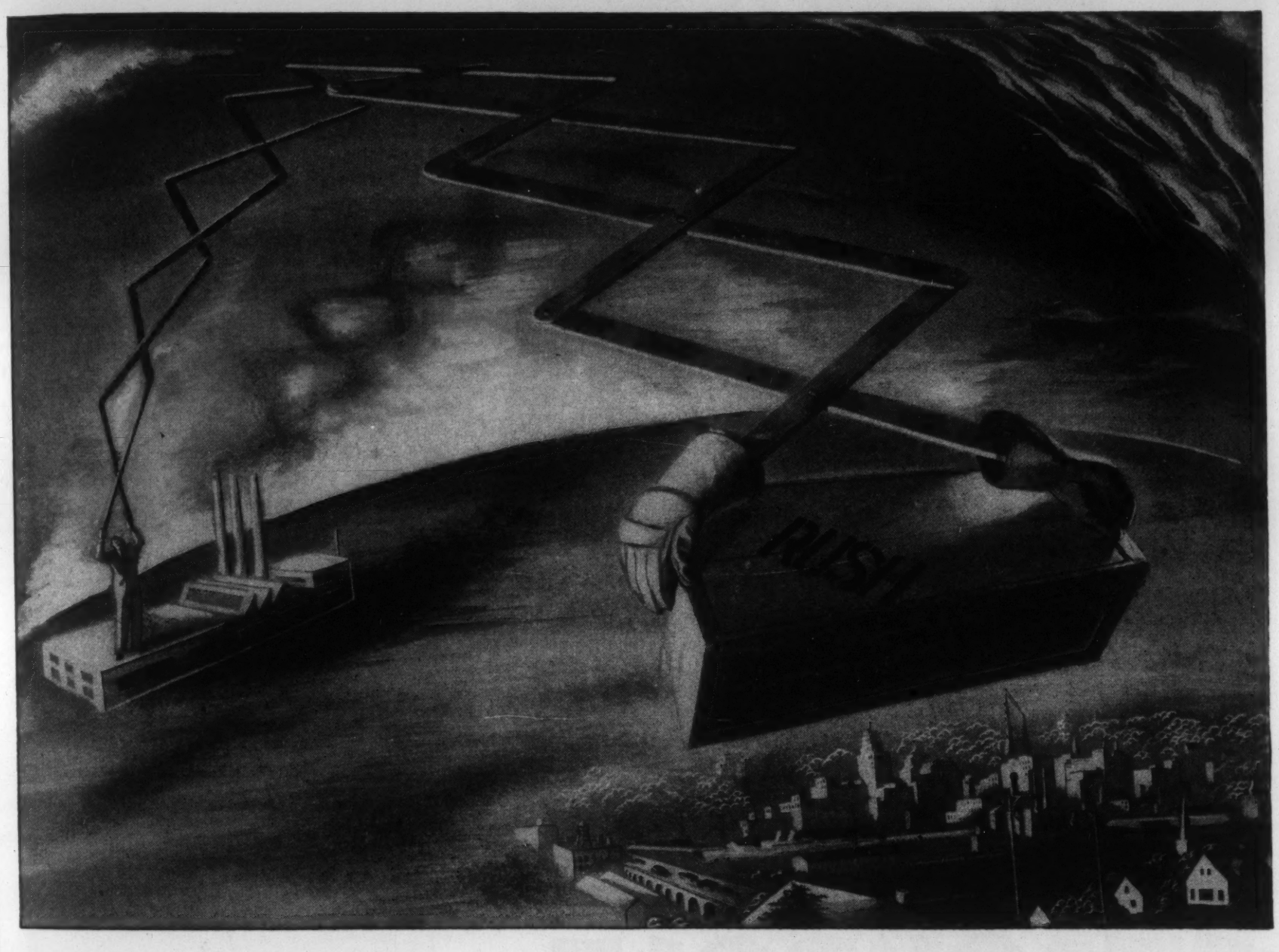


Figure it every way—in time, tooling costs, manpower need—there's a lot you may save by talking things over with a custom molder of Durez plastics.

Your molder can often see an opportunity to use plastics that is not apparent on the surface. Representing a mature industry, he is equipped to take hold on jobs involving plastics alone or in conjunction with other materials, and carry them through to completion with time-saving dispatch.

Accustomed to serving leading manufacturers in many fields, molders maintain highly competent design, engineering and production staffs. They hasten to adopt the newest in equipment and methods in the interest of low delivered cost.

Perhaps most valuable of all is the knowledge of plastic materials your molder uses in interpreting your needs. When resistance to heat, moisture, or chemicals is required, plus impact strength, unusual electrical properties, and high surface lustre, he recognizes the advantages of Durez phenolics. Because he knows them well, he can specify the one that best fits the job.

All the assistance the Durez staff can lend you and your molder in furthering your product plans will be given gladly. Offices in leading cities.

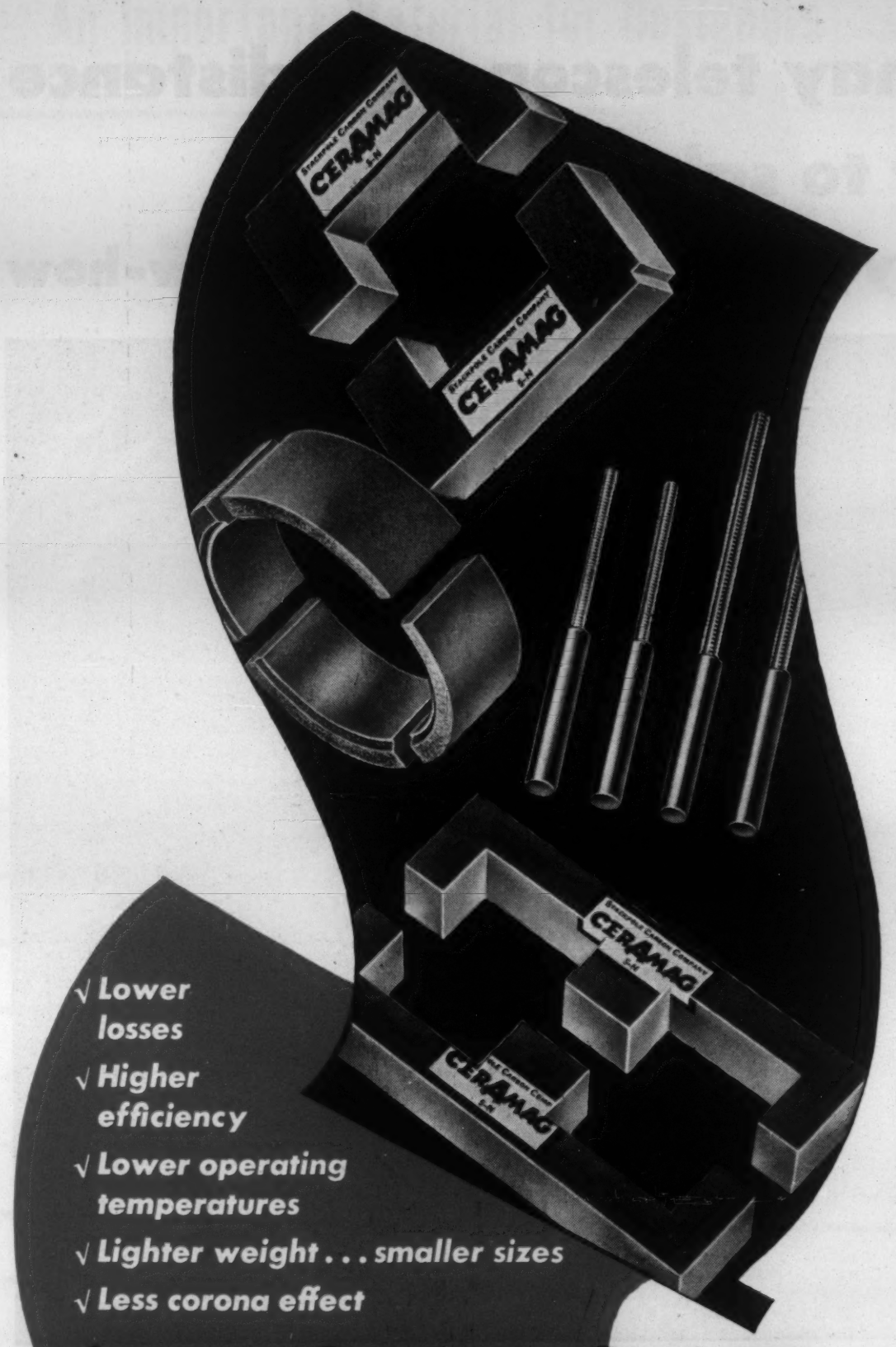
*Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Ask us to send a copy regularly. Durez Plastics & Chemicals, Inc., 1407 Walck Road, North Tonawanda, N. Y.*

DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- PROTECTIVE COATING RESINS

**PHENOLIC PLASTICS THAT FIT THE JOB**


√ Lower losses
√ Higher efficiency
√ Lower operating temperatures
√ Lighter weight . . . smaller sizes
√ Less corona effect
√ Higher permeability

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ELECTRONIC COMPONENTS DIVISION

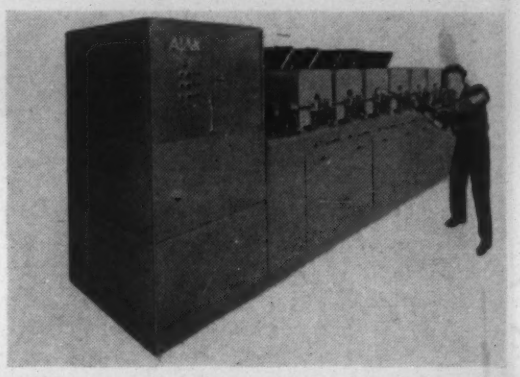
STACKPOLE CARBON COMPANY, St. Marys, Pa.

FIXED RESISTORS • VARIABLE RESISTORS
IRON CORES • CERAMAG CORES • LINE and SLIDE SWITCHES • MOLDED COIL FORMS • GA "GIMMICK" CAPACITORS, etc.


# New Materials and Equipment

bar stock for automotive forgings. Billet sizes from 1 to 4 in. can be handled and are heated to 2250 F at a maximum rate of 7500 to 8500 lb per hr.

An important feature of the equipment is that it has space for eight heating stations with some 30 interchangeable heating



*This new induction forge heating equipment has space for eight heating stations with 30 interchangeable heating units.*

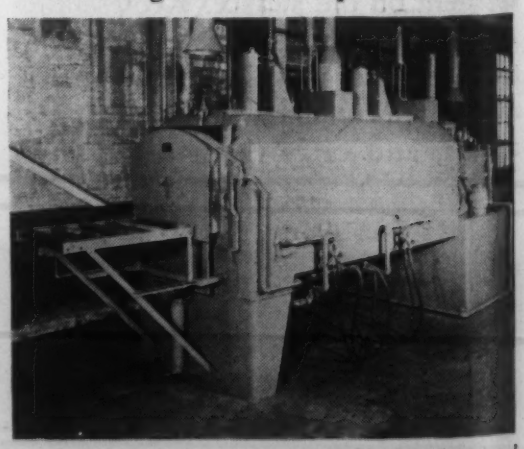
units to accommodate the different sizes of bars. Each station is said to have its own transformer, capacitators, push buttons, signal lights, automatic timers and protective relays; yet they can be arranged to work together in a wide variety of combinations to feed uniformly heated billets to the forge at a rate timed for maximum production.

## Bright Heat Treating Unit

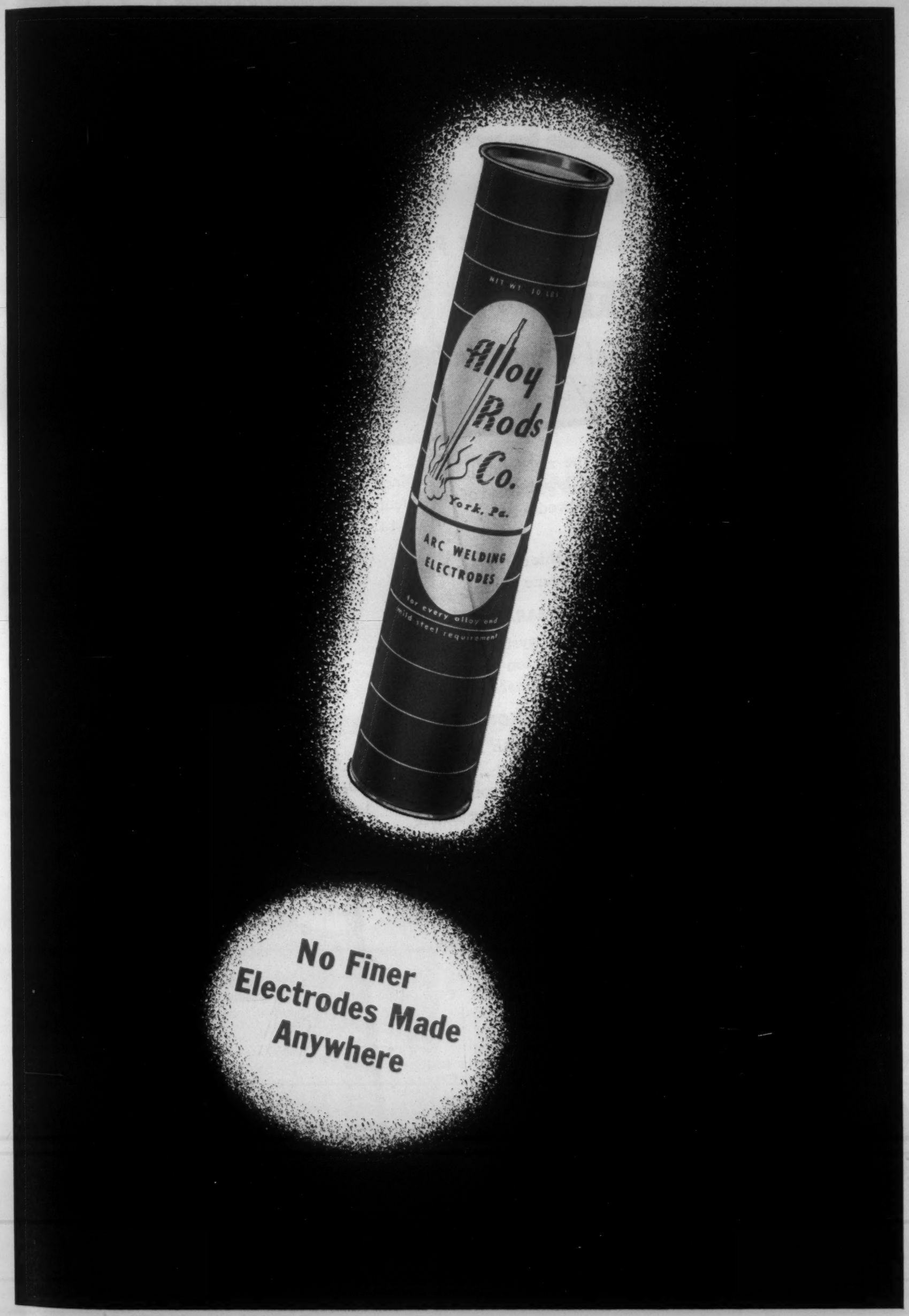
A fully automatic and controlled atmosphere unit for bright production heat treating rated at 600 lb per hr has been announced by *Ipsen Industries, Inc.*, 715 S. Main St., Rockford, Ill.

Especially designed for bright carburizing and carbonitriding, the standard T-600 is also said to handle straight heat treating or annealing operations.

Consisting of two independently controlled heating zones sealed to a combination cooling chamber and quench tank, the



*This bright heat treating unit is designed for bright carburizing and carbonitriding.*


NET WT 10 LBS
Alloy Rods Co.
York, Pa.
ARC WELDING ELECTRODES
for every alloy and mild steel requirement
No Finer Electrodes Made Anywhere

# BRIGHT FINISHING SYSTEM

# SPARKLES

## LIKE CHROME!

***Leading manufacturers approve zinc plate***

***and IRIDITE® Bright***

***to replace conventional chrome plating***

If your problem is finding the right finish to replace conventional chrome plating, follow the lead of prominent manufacturers of all types of products . . . switch to zinc plate and Iridite Bright.

Here's what you get when you use this chromate finishing system to replace conventional chrome plating.

**SPARKLING BRIGHT APPEARANCE**

The zinc plate and Iridite Bright system resembles chrome so closely that visual inspection can scarcely tell the difference! And, the brilliance *lasts.*

**BETTER CORROSION PROTECTION**

Yes, you actually get better protection with zinc plate and Iridite Bright than with chrome plating . . . up to twice the life under accelerated salt spray conditions! And, by applying a clear baking lacquer over the Iridite coating you can increase the abrasion resistance and lasting qualities of this bright finishing system, at the same time making possible a greater salt spray protection.

**LOWER FINISHING COSTS**

One metal, zinc, replaces three so you save material costs and plating time. Iridite Bright goes on in a non-electrolytic chemical dip.

**Write or call today for your copy of our new Technical Bulletin describing all phases of this bright finishing system in detail. Tell us your bright finishing requirements. If possible send sample parts for test processing.**

Iridite is approved under government specifications

**ALLIED RESEARCH PRODUCTS**
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

**REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES; West Coast: L. H. BUTCHER COMPANY**
**Manufacturers of Iridite Finishes**
**for Corrosion Resistance and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals.**


# New Materials and Equipment

unit is claimed to automatically load, transfer and quench the work.

Other features include a furnace, which is either gas or electric; and a water jacketed chamber with automatic temperature control. The quench tank has built-in oil heating and cooling coils, also with automatic temperature control and, when insulated, can be used for Mar-tempering.

## Cleaning & Finishing

### Portable Polishing Head

A new portable brush-backed polishing head has been developed by *Vonnegut Moulder Corp.,* 1819 Madison Ave., Indianapolis 25.

Consisting of two principal parts—an outer shell or drum, holding 16 replaceable brushes and a center spool on which are coiled 16 strips of abrasive cloth—the port-

*This polishing head has the ability to follow irregular surfaces instead of reshaping them.*

able head is said to be ideal for finishing operations on all classes of shaped surfaces.

Since an entirely different set of results may be obtained with the same head by changing the grade and grit of abrasive strips used, its applications are broad. The more common uses are: sanding wood, plastics, ceramics, leather; sanding stain, primer and filler coats; removing bubbles and other defects from paint and enamel finish coats; feathering-out operations; removing rust, scale and for clean-up operations; polishing out die marks on formed metal parts; smoothing die castings.

Also, when size and shape permit, the head is claimed to be suitable for remov-

# LEPEL *offers a New*

# LOW COST *High Frequency* HEATING UNIT

**AT A PRICE SO LOW THAT NO MACHINE SHOP, TOOL ROOM OR LABORATORY CAN AFFORD TO BE WITHOUT IT!**

Unit illustrated brazing carbide tips to cutting tools. Shanks up to 1½" square can be satisfactorily brazed.

- **SMALL and COMPACT**
  Conveniently operated on bench or table—no mounting necessary.
- **ECONOMICAL OPERATION**
  No special power installation required. Operates on 110 volts, 60 or 50 cycle line at unity power factor.

**DOES ALL THESE JOBS** *Faster, Better and Cheaper*
**BRAZING, SOLDERING HARDENING, ANNEALING DRAWING AND MELTING**

- **FULLY GUARANTEED**
  Guaranteed for continuous duty cycle and stated performance.
- **LOW COST**
  Complete unit with line connection and load coil

**$870.00** f.o.b. factory

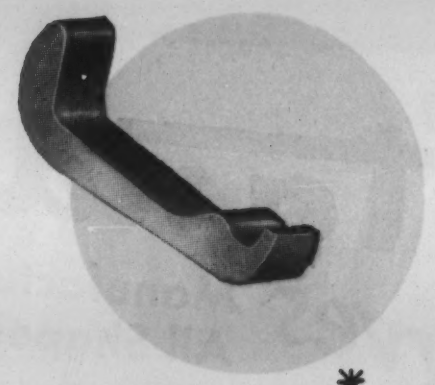
**WILL HEAT TO 1500° F.**

| | |
|---|---|
| ⅛" steel rod 1" length in approx. | 1 second |
| ¼" " " " " " " | 3 seconds |
| ½" " " " " " " | 15 seconds |
| 1" " " " " " " | 60 seconds |

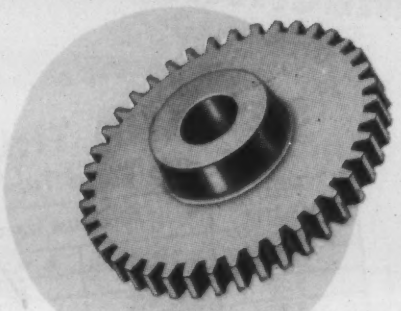
Will melt 4 ounces of brass or steel in 4 minutes.
Equally well suited for heating of non-ferrous metals.

**LEPEL HIGH FREQUENCY LABORATORIES, Inc., 39 West 60th Street, New York 23, N. Y.**

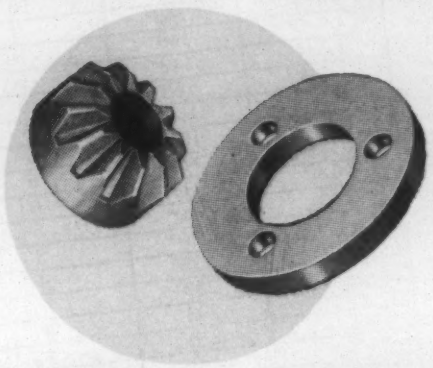
**WRITE FOR LEPEL CATALOG MM-7**



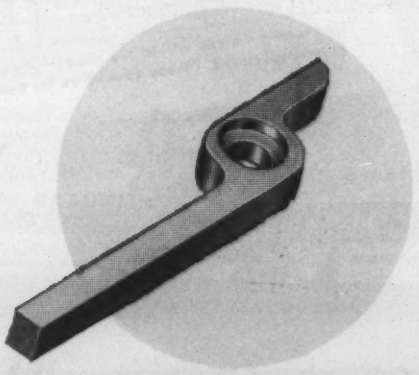
# POWDERMET* PARTS



# INCREASE YOUR



# PRODUCTION CAPACITY



**PRECISION PARTS ARE DELIVERED READY FOR ASSEMBLY WITHOUT FURTHER PROCESSING!**

Gears, bearings, electronic components and small assembly parts are fabricated to your specifications and tolerances. You avoid troublesome raw material procurement problems, decrease the burden on over loaded equipment in your own plant and reduce costs at the same time. Send for this free booklet today and see how "Powdered Metal In Your Production Picture" will increase your output!

**POWDERED METAL PRODUCTS CORPORATION** *of America*

**9335 West Belmont Avenue, Franklin Park, Illinois**

**PMP**

*Trade Mark

"Standard"

Serves Manufacturers Who Use All Shapes and Sizes of

MECHANICAL STEEL TUBING

SIZE AND THICKNESS CHART

of Electric Weld Tubing for Mechanical Use

| TUBE DIAMETER *O.D. SIZE | MAXIMUM WALL | | MINIMUM WALL | |
|---|---|---|---|---|
| | DECIMAL | B. W. GAUGE | DECIMAL | B. W. GAUGE |
| 1/2" | .065" | 16 | .028" | 22 |
| 5/8" | .065" | 16 | .028" | 22 |
| 3/4" | .065" | 16 | .028" | 22 |
| 7/8" | .083" | 14 | .028" | 22 |
| 1" | .109" | 12 | .028" | 22 |
| 1-1/8" | .109" | 12 | .028" | 22 |
| 1-1/4" | .134" | 10 | .028" | 22 |
| 1-3/8" | .134" | 10 | .028" | 22 |
| 1-1/2" | .148" | 9 | .035" | 20 |
| 1-5/8" | .148" | 9 | .035" | 20 |
| 1-3/4" | .148" | 9 | .035" | 20 |
| 1-7/8" | .165" | 8 | .035" | 20 |
| 2" | .165" | 8 | .035" | 20 |
| 2-1/4" | .180" | 7 | .035" | 20 |
| 2-1/2" | .203" | 6 | .035" | 20 |
| 2-3/4" | .203" | 6 | .049" | 20 |
| 3" | .220" | 5 | .049" | 18 |
| 3-1/4" | .220" | 5 | .049" | 18 |
| 3-1/2" | .238" | 4 | .049" | 18 |
| 3-3/4" | .238" | 4 | .049" | 18 |
| 3-7/8" | .238" | 4 | .049" | 18 |
| 4" | .238" | 4 | .049" | 18 |
| 4-1/4" | .250" | 4 | .049" | 18 |
| 4-1/2" | .250" | 3 | .065" | 18 |
| 4-3/4" | .250" | 3 | .083" | 16 |
| 5" | .180" | 7 | .083" | 14 |
| 5-1/2" | .180" | 7 | .083" | 14 |
| | | | .083" | 14 |

*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.

Manufacturers requiring tubing for civilian or defense production prefer "Standard's" Electric Weld Steel Tubing for many reasons! "Standard's" Electric Weld is produced in one of the most versatile and complete mills of its kind in the world. "Standard's" 33 years of specialized tubing "know-how", and monthly production of millions of feet of stainless and carbon steel tubing, in wide range of sizes and gauges, assure you of utmost satisfaction. No problem of tolerance, precision or severest application for mechanical, structural, or pressure tubing is too difficult.

STAINLESS STEEL TUBING
⅛" to 3" O.D. . . . .028 to .095 wall

ABOVE CHART COVERS ROUND CARBON STEEL TUBING . . .

•

EQUIVALENT SQUARES, RECTANGULARS AND SPECIAL SHAPES ARE ALSO AVAILABLE.

THE STANDARD TUBE CO.

Detroit 28, Michigan

Welded Tubing — Fabricated Parts

STANDARDIZE with STANDARD — It Pays

# New Materials and Equipment

ing burrs and polishing surfaces of the dies and molds which are used for making such parts; polishing all kinds of ferrous and nonferrous surfaces in preparation for buffing operations; etc.

## Compact Tumbling Barrels

Made in both constant and variable speeds by *D. J. Murray Manufacturing Co.*, Wausau, Wis., the new Murco tumbling barrels are said to have both motor and operating mechanism totally enclosed. The only exposed parts are the controls and magnetic reversing starter, making them completely safe in operation.

The 7½-hp constant speed model operates at 25 rpm, while the variable speed 7½ hp is said to have speeds from 8 rpm slow speed to 25 rpm high speed, with an infinite range of speeds in between to meet operating conditions. Speed changes can be made while the barrel is in motion and require no changes of belts or pulleys. A foot operated hydraulic brake at floor level stops the barrel in any position, facilitating loading and unloading and preventing accidental dumping of loads.

Murco tumbling barrels are also available in 5- and 3-hp constant and variable speed models.

## Electronic Device for Paint Spraying

*Ashdee Products, Inc.*, 18029 Dixie Highway, Homewood, Ill., have announced a new electronic accessory for paint spray units, which, operating on the electrostatic attraction principle, greatly reduces overspray and cuts waste to a minimum.

In operation, a negative charge is established in the paint particles as they leave the spray gun. The paint spray containing the negative charge is then attracted to the part to be coated, which is at ground potential. With this method, spraying from a fixed position is said to allow the paint to reach around corners and cover top and bottom with a uniform coating.

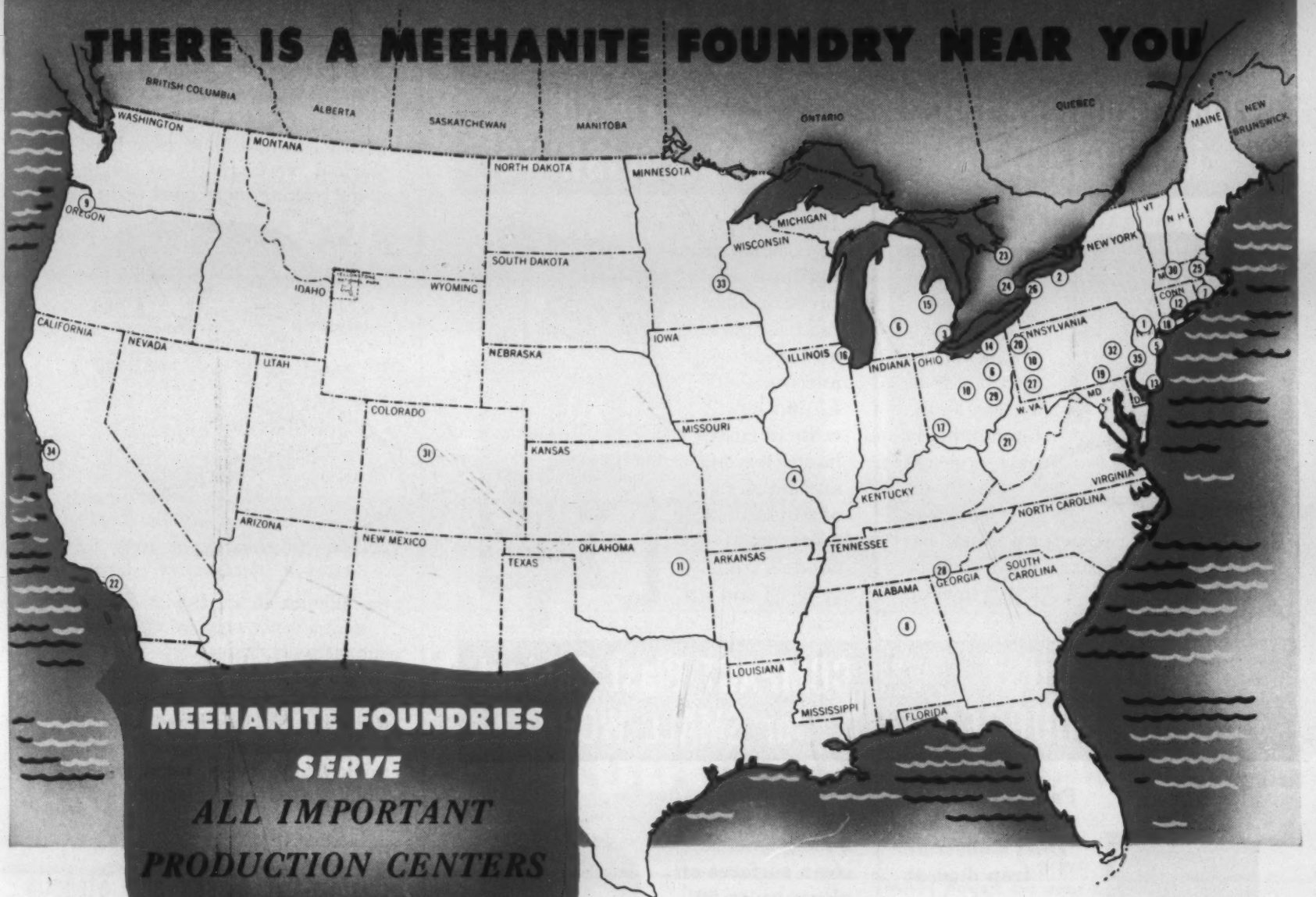
## Coating Machine

The Norris Gyromat, which is said to apply a full coverage coating of from 0.0008- to 0.025-in. thickness of any coating material in one passage at high speed,

*When You Want*

# QUALITY and SERVICE

## THERE IS A MEEHANITE FOUNDRY NEAR YOU




**MEEHANITE FOUNDRIES**
***SERVE***
***ALL IMPORTANT***
***PRODUCTION CENTERS***

1. American Brake Shoe Co. . . . . Mahwah, New Jersey
2. The American Laundry Machinery Co. . . . . Rochester, New York
3. Atlas Foundry Co. . . . . Detroit, Michigan
4. Banner Iron Works . . . . . St. Louis, Missouri
5. Barnett Foundry & Machine Co. . . . . Irvington, New Jersey
6. E. W. Bliss Co. . . . . Hastings, Mich. and Canton, O.
7. Builders Iron Foundry . . . . . Providence, Rhode Island
8. Continental Gin Co. . . . . Birmingham, Alabama
9. Crawford & Doherty Foundry Co. . . . . Portland, Oregon
10. The Cooper-Bessemer Corp. . . . . Mt. Vernon, Ohio and Grove City, Pa.
11. Empire Pattern & Foundry Co. . . . . Tulsa, Oklahoma
12. Farrel-Birmingham Co., Inc. . . . . Ansonia, Connecticut
13. Florence Pipe Foundry & Machine Co. . . . . Florence, New Jersey
14. Fulton Foundry & Machine Co., Inc. . . . . Cleveland, Ohio
15. General Foundry & Manufacturing Co. . . . . Flint, Michigan
16. Greenlee Foundry Co. . . . . Chicago, Illinois
17. The Hamilton Foundry & Machine Co. . . . . Hamilton, Ohio
18. Hardinge Company, Inc. . . . . New York, New York
19. Hardinge Manufacturing Co. . . . . York, Pennsylvania
20. Johnstone Foundries, Inc. . . . . Grove City, Pennsylvania
21. Kanawha Manufacturing Co. . . . . Charleston, West Virginia
22. Lincoln Foundry Corp. . . . . Los Angeles, California
23. E. Long Ltd. . . . . Orillia, Ontario
24. Otis Elevator Co., Ltd. . . . . Hamilton, Ontario
25. The Henry Perkins Co. . . . . Bridgewater, Massachusetts
26. Pohlman Foundry Co., Inc. . . . . Buffalo, New York
27. Rosedale Foundry & Machine Co. . . . . Pittsburgh, Pennsylvania
28. Ross-Meehan Foundries . . . . . Chattanooga, Tennessee
29. Shenango-Penn Mold Co. . . . . Dover, Ohio
30. Standard Foundry Co. . . . . Worcester, Massachusetts
31. The Stearns-Roger Manufacturing Co. . . . . Denver, Colorado
32. Traylor Engineering & Mfg. Co. . . . . Allentown, Pennsylvania
33. Valley Iron Works, Inc. . . . . St. Paul, Minnesota
34. Vulcan Foundry Co. . . . . Oakland, California
35. Warren Foundry & Pipe Corporation . . . . . Phillipsburg, New Jersey

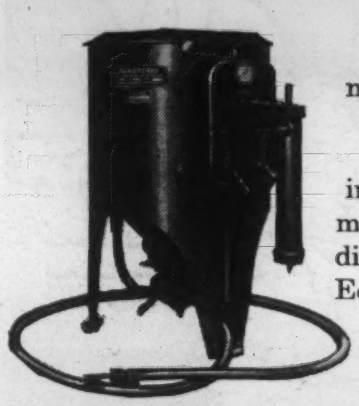
**MEEHANITE** ®

*New Rochelle, N.Y.*

*"This advertisement sponsored by foundries listed above."*

Here's BIG NEWS on Blast Cleaning Dust Control Precision Finishing

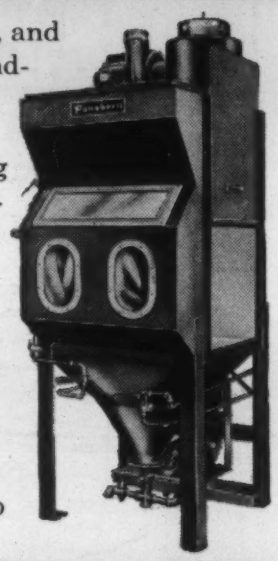
**Blast Cleaning Unit is PORTABLE!**



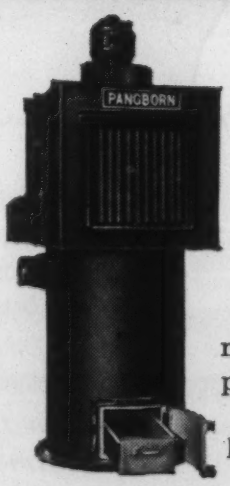
Ideal for maintenance and many other jobs, including removal of rust, dirt, scale, etc. Economically cleans large objects like tanks, bridges, structural work before painting. Six sizes, stationary or portable, from.....**$170.00** and up

**Hydro-Finish SPEEDS POLISHING!**

Removes scale, and directional grinding lines . . . prepares surfaces for plating and holds tolerances to .0001"! Liquid blast reduces costly hand cleaning and finishing of molds, dies, tools, etc. Models from **$1295.00** and up



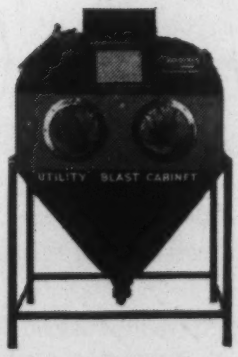
**STOP DUST at the SOURCE!**




Pangborn industrial type Unit Dust Collectors trap dust at source. Machine wear is minimized, housekeeping and maintenance costs reduced. Solves many grinding and polishing nuisances and material losses. Models from **$286.00** and up

**COMPACT Blast Cabinet for SMALL WORK!**

Ideal for producing smooth, clean surfaces on pieces up to 60" x 36" in size. Cleans metal parts, removes rust, scale, grime, dirt, paint, etc., in a few seconds. Saves money all year 'round. Models from **$315.00** up




*Look to Pangborn for the latest developments in Blast Cleaning and Dust Control Equipment*

**Pangborn** MAIL COUPON FOR DETAILS

*Check for more information*

- ☐ Blast Cleaning Cabinets
- ☐ Blast Cleaning Machines
- ☐ Unit Dust Collectors
- ☐ Hydro-Finish Cabinets

**PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.**

Gentlemen: Please send me more information on the equipment I've checked at the left.

Name.....

Company.....

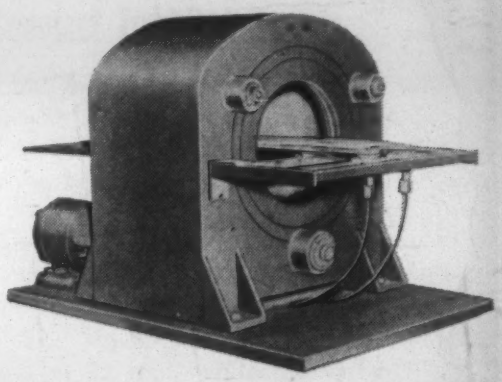
Address.....

City.....Zone....State.....


# New Materials and Equipment

is now offered by *The Gyromat Corp.*, P.O. Box 600, Fairfield, Conn.

In operation, high-speed rotors atomize and direct the paint to the work being passed through the rotating bowl. Excess material (overspray) is caught by the unit's rotating inner bowl and returned to



*This new coating machine applies a full coverage of coating of from 0.0008- to 0.025-in. thickness in one passage.*

the annulus in its former fluid state and reused, a vapor pressure equilibrium being automatically maintained.

Said to offer great savings in time, money and material, the machine's versatile services include improved coatings for: ceramics, delicate electrical relays, electronic parts, bulky metal products and oddly shaped plastic items.

## Custom-Cut Masks and Stencils

New custom die cut stencils and masks for industrial and consumer finishing operations have been announced by *Gleicher Manufacturing Corp.*, 141 Grelinghuysen Ave., Newark 5.

Uses for these pressure sensitive parts are said to include:

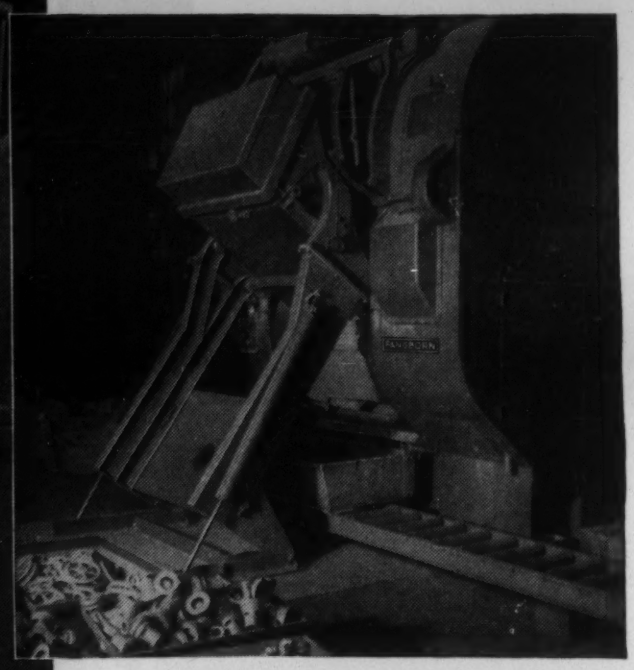
1. Separating—colors in brush or spray painting on automobiles, machinery, toys, glass, porcelain, leather, etc.
2. Sandblasting—patterns on glass and soft metals, such as copper, brass, etc.
3. Protecting—highly polished machine surfaces and name plates.

Available mounted on an easily removed interliner to insure faster handling, the new masks and stencils are claimed to eliminate high labor costs found in hand operations.

## Cleaning Process

A new process, which is said to clean steel cartridge cases 50% faster than conventional methods, has been announced by the *B. F. Goodrich Co.*, Akron, Ohio.

Known as the B. F. Goodrich-Curran



MECHANIZED LOADING!

SIMPLIFIED UNLOADING

**These action photographs prove Pangborn ROTOBLAST Barrels are *easy to operate*. This 14' ROTOBLAST Barrel is shown in use at the Frick Company. It speeds cleaning by replacing four old-style machines and a secondary pickling operation. And with this machine two men can clean half the entire foundry's output—at an annual saving of $2540.00 on labor!**

# ...re's How Pangborn ROTOBLAST* Barrels SPEED DEFENSE PRODUCTION!

**SPEED** is essential to defense production . . . and in case after case, Pangborn ROTOBLAST Barrels have proved they can clean castings up to 24 times faster than conventional equipment. Even loading is fast! With Pangborn automatic loading equipment, any size ROTOBLAST Barrel (from 3½ to 28 cubic feet) can be loaded *in one minute or less!*

What's more, Pangborn ROTOBLAST Barrels assure high-quality cleaning. The exclusive "rocking" action of the Barrel exposes all surfaces to the blast stream . . . makes sure pockets of intricate pieces are completely cleaned. And ROTOBLAST Barrels cost less to operate. Horsepower requirements average 87% less, smaller crews are needed and automatic abrasive recovery assures maximum economy.

***FOR FASTER BLAST CLEANING*** install Pangborn ROTOBLAST Barrels in your cleaning room. Bulletin 213 gives you full details, specifications and actual performance as reported by users. Write today to: PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

***Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment.***

## ROTOBLAST . . .

**SAVES LABOR** with push-button operation

**SAVES SPACE** because machines are compact

**SAVES TIME** by cleaning more loads per day

**SAVES POWER** since no compressor is needed

**SAVES TOOLS** because all scale is removed

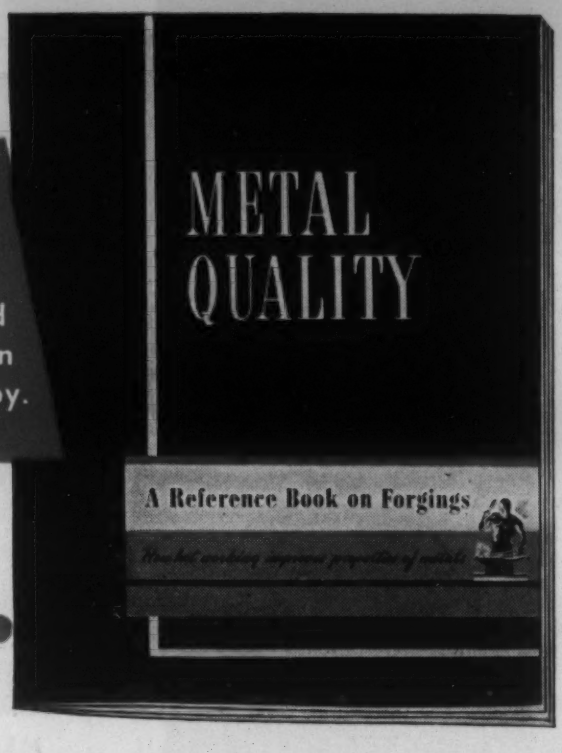
# Pangborn

## BLAST CLEANS CHEAPER

**with the right equipment for every job**

*Trademark of the Pangborn Corporation.

Engineering, production and economic advantages obtainable with forgings are presented in this Reference Book on forgings. Write for a copy.




**Never underestimate the preference of users of your product for the factor of greater safety that is inherent in forgings. This factor of greater safety results from toughness and strength, in correct proportion, as found only in closed die forgings. Consult a forging engineer about the mechanical properties required for your product.**

DROP FORGING ASSOCIATION
605 HANNA BLDG. • CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal", 1949 Edition.

Name .....
Position .....
Company .....
Address .....


# New Materials and Equipment

automatic spray pickling machine, the new system is the defense version for cleaning and pickling steel. Switched by re-design to production for defense, the process is now claimed to be equipped to handle the larger sizes of artillery and mortar shell cases at a high production rate.

Development of the new process is especially significant at this time, according to the manufacturer, because due to the critical copper supply most larger calibre ammunition produced in this country in the future will be made with steel cases rather than brass. Equipment needed for the process is lined with rubber, which withstands the highly corrosive action of the pickling acids used.

## Welding & Joining

### Silver Solder

A new silver solder, which is claimed to possess excellent corrosion resistance and an unusually narrow plastic range, has been announced by *All-State Welding Alloys Co., Inc.*, 273 Ferris Ave., White Plains, N. Y.

Originally developed for broad application in food handling equipment, the new alloy, being cadmium free, will be more available than silver solders and will find use in many industrial applications.

No. 155 Premium Silver Brazing Rod contains 55% silver, has a low working temperature of 1155 F, and develops a tensile strength of 50,000 psi. Available in wire, strip and rings, the alloy is for torch or furnace application with No. 100 or 200 Brazaloy flux to copper and copper-bearing alloys and with No. 100 to ferrous alloys.

## Forming & Machining

### Small Pneumatic Die Grinder

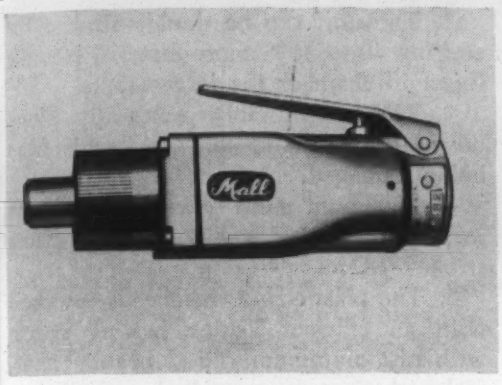
Designed to solve many precision grinding problems on small dies, castings and hard to get at spots, the new pneumatic die grinder offered by *Mall Tool Co.*,

*(Continued on page 135)*

# New Materials and Equipment

7725 S. Chicago Ave., Chicago 19, is 4⅜ by 1¼ in. in size and weighs only 12 oz.

A choice of lever or button type throttles with a special collet guard allows the




*Eight sizes of Erickson precision collets are available with this precision grinder.*

operator to hold the tool close to the work, permitting fingertip operation with better balance in the tightest working areas, while an arbor runout within 0.0015 in. is said to allow extremely accurate work where pin-point grinding is required.

Other features claimed for the new grinder are:

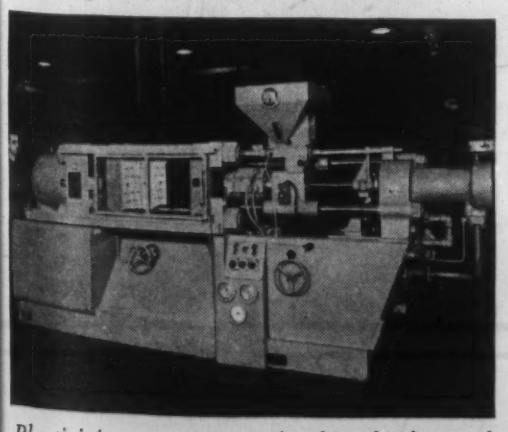
1. A rotary vane type air motor, which is cool running and develops 26,000 rpm.

2. An exhaust, directed away from the operator, where it cleans and cools the work.

3. A motor silencer that eliminates annoying high pitch tones.

## Injection Molding Machine

A new high-speed injection molding machine for the plastics industry has been announced by the *Hydraulic Press Manufacturing Co.,* Mt. Gilead, Ohio.



*Plasticizing capacity of this high-speed injection molding machine is 60 lb per hr.*

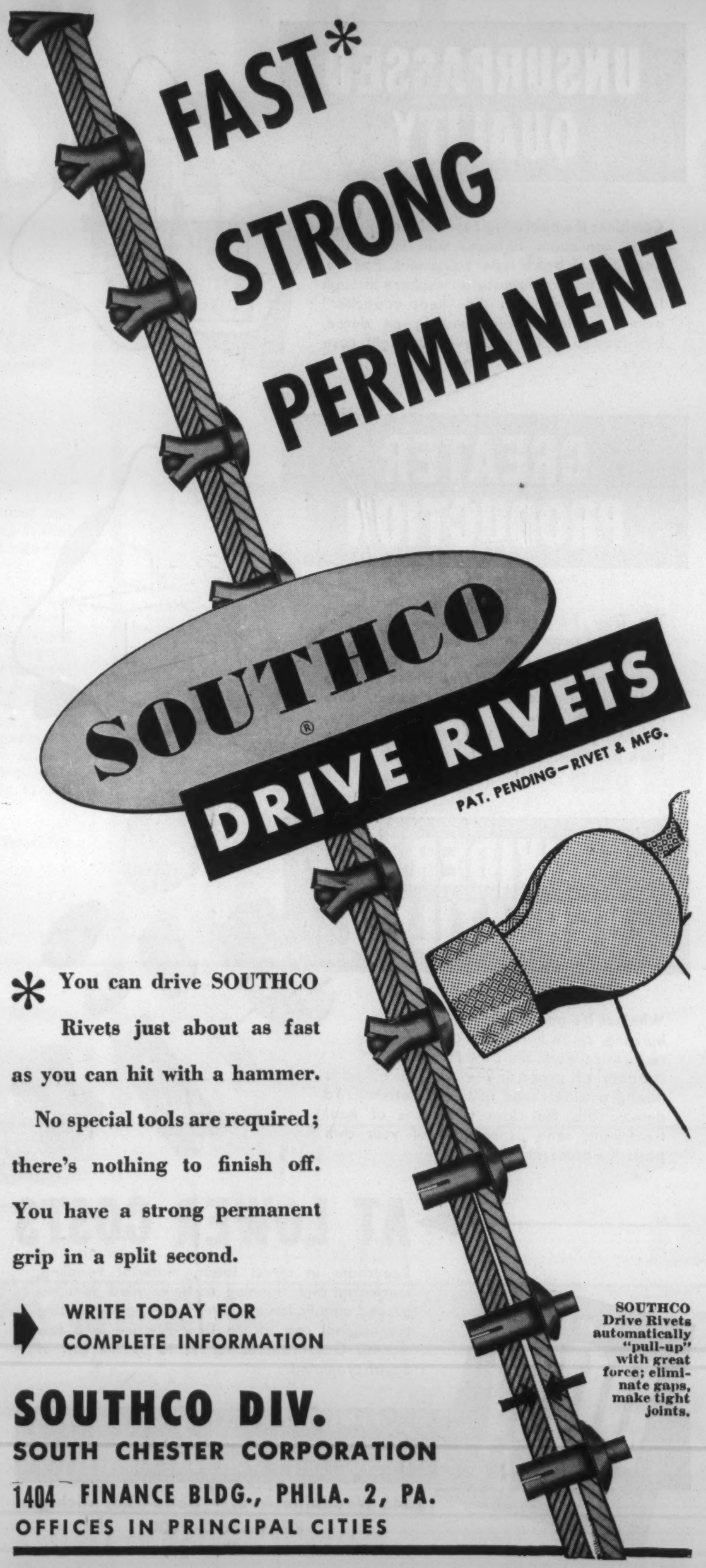
Said to cut rejects to less than 1%, this new model, H-P-M 9, offers many new features:

1. The hydraulic system is completely


FAST* STRONG PERMANENT

SOUTHCO® DRIVE RIVETS

PAT. PENDING—RIVET & MFG.



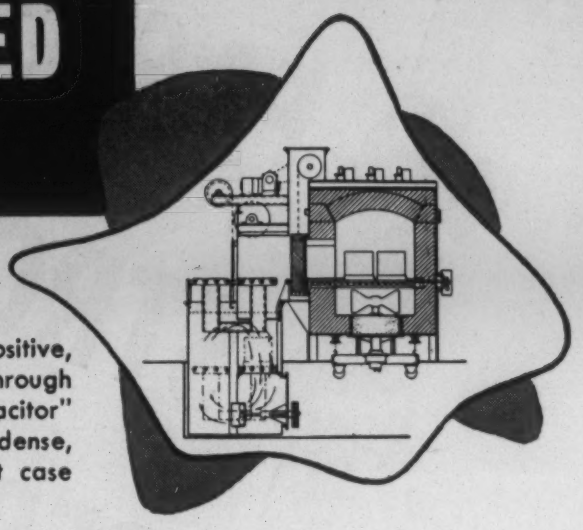
* You can drive SOUTHCO Rivets just about as fast as you can hit with a hammer. No special tools are required; there's nothing to finish off. You have a strong permanent grip in a split second.

WRITE TODAY FOR COMPLETE INFORMATION

SOUTHCO Drive Rivets automatically "pull-up" with great force; eliminate gaps, make tight joints.

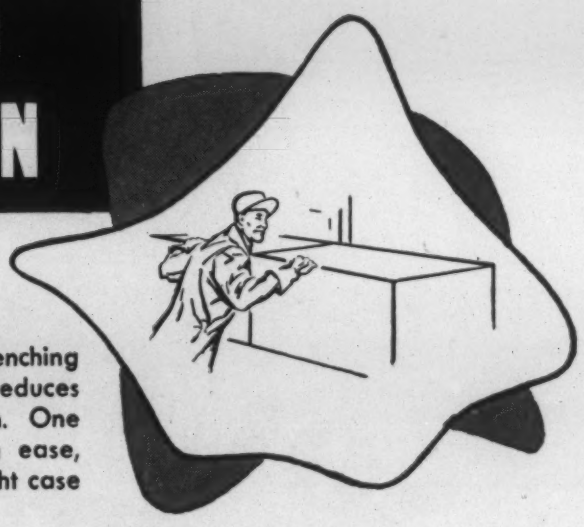
SOUTHCO DIV.
SOUTH CHESTER CORPORATION
1404 FINANCE BLDG., PHILA. 2, PA.
OFFICES IN PRINCIPAL CITIES

# UNSURPASSED QUALITY



Combines the operating economies of large continuous furnaces with the flexibility of batch-type equipment. Positive, directed flow of furnace atmosphere through load, combined with the "heat capacitor" assures rapid, uniform heating on dense, bulk-loaded parts and even on light case work.

# GREATER PRODUCTION



The Dow Furnace has established production records in plants throughout the country. Forced, uniform quenching from atmosphere gives full hardness, reduces distortion, eliminates decarburization. One man can operate *two* furnaces with ease, producing as much as 1500-lbs. of light case work per hour.

# WIDER VERSATILITY

Whether it's gas cyaniding, gas carburizing, clean hardening or carbon restoration work, the Dow Furnace is capable of processing a variety of parts having a wide range of heat treatments. To demonstrate the close tolerances of heat treatments, send us samples of your own parts for processing.

# AT LOWER COSTS

Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, have resulted in savings amortizing the original cost of the Dow Furnace in a few months. Gas cyanides for ¼ to ⅓ the cost of liquid cyaniding.

THE DOW FURNACE COMPANY

FIRST
WITH MECHANIZED BATCH-TYPE
CONTROLLED ATMOSPHERE FURNACES

12045 Woodbine Ave. • Detroit 28, Michigan
KEnwood 2-9100


# New Materials and Equipment

out in the open for easy maintenance and service.

2. The unit can be double stroked for stuffing 40 to 50% more material into the injection chamber for larger shots.

3. Three adjustable automatic slow-downs protect mold and mold parts from being damaged.

4. Maximum mold space is 17¼ by 26 in.; daylight opening—27 in.; mold clamp stroke—18 in.

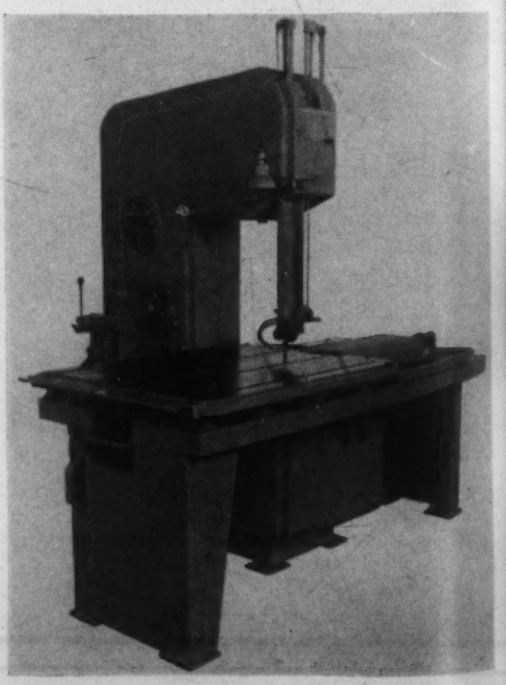
5. The plasticizing chamber is equipped with an efficient 2-zone heating system with cast aluminum calrod heating units, and each zone is controlled with a pyrometer indicating temperature instrument.

6. Plasticizing capacity is 60 lb per hr.

The new machine can be equipped with a pre-plasticizing injection unit, which, according to the manufacturer, will increase shot capacity to 20 oz of polystyrene with plasticizing capacity tripled.

## Band Machine with Hydraulic Work Table

*Doall Co.*, Des Plaines, Ill., has announced production of a band machine said to be fully equipped to handle sawing,



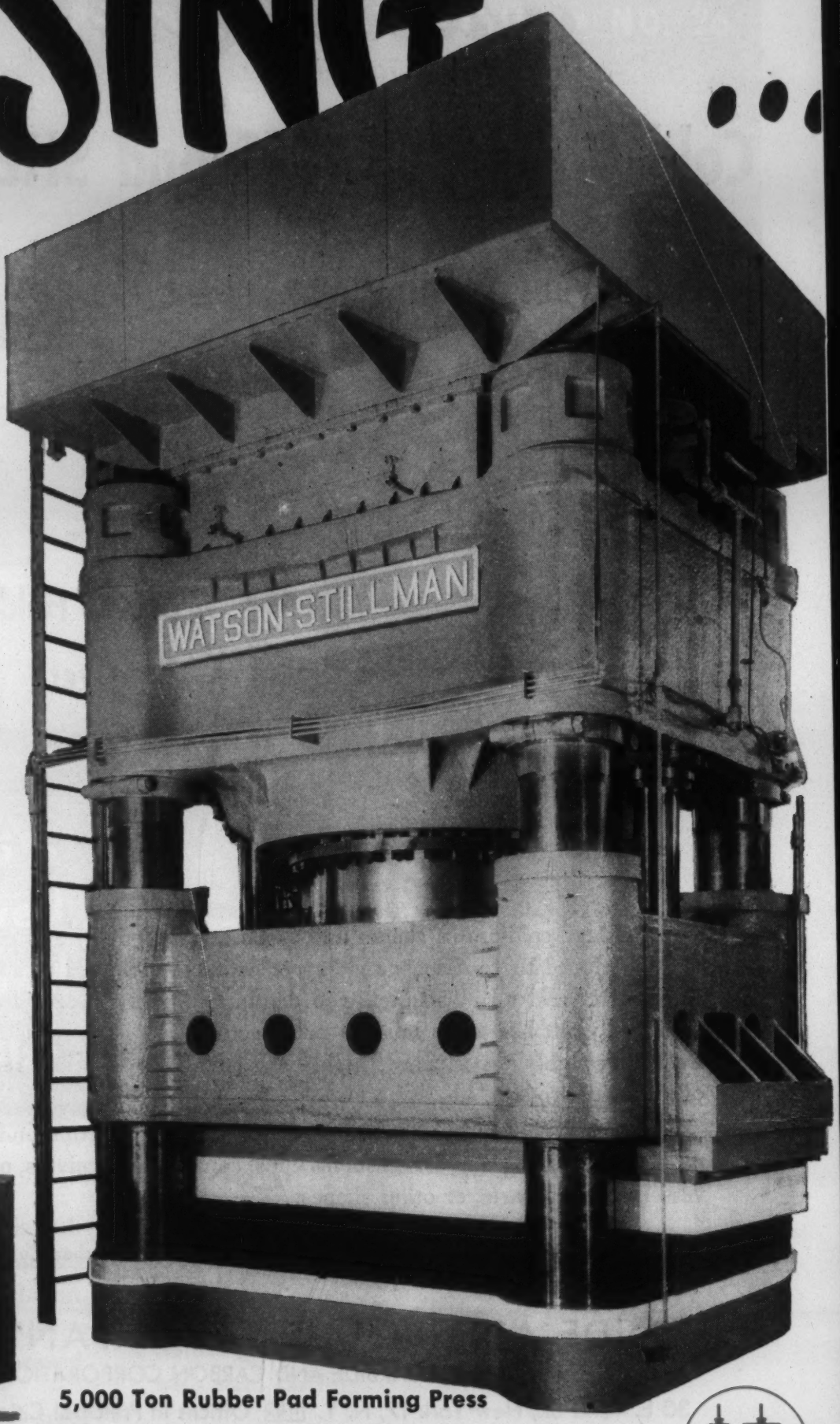
*Cutting speeds of this band machine are infinitely variable from 40 to 10,000 fpm.*

grinding or filing of heavy metal work sections.

The new Contour-matic, equipped with a 36-in. stroke heavy duty hydraulic work table, is operated hydraulically by control knobs in a central panel on the column of the machine convenient to the operator,

# PRESSING ...

## out the ARMS for UNCLE SAM!



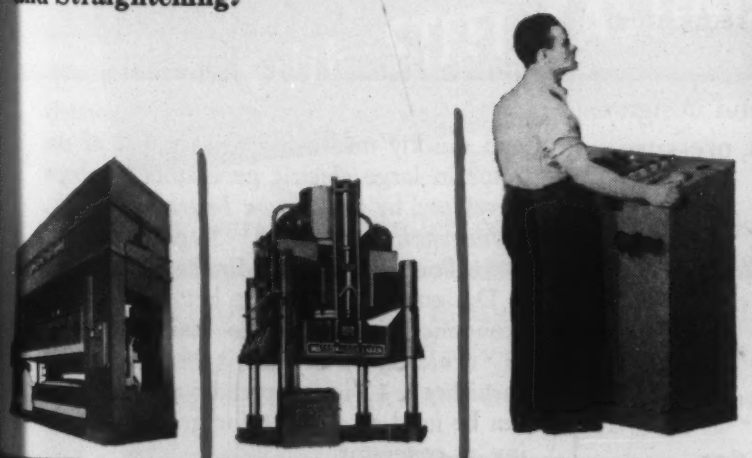

5,000 Ton Rubber Pad Forming Press

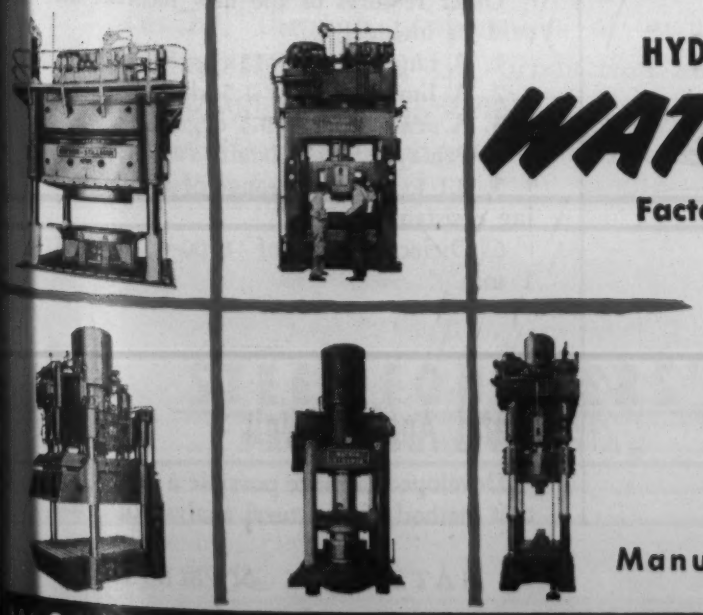
**Planes . . . tanks . . . guns . . . shells . . . shell cases or any one of a thousand and one other items that must be produced, as long as it can be pressed out of metal, there's a W-S Press to do the job . . . and more economically, too.**

**W-S Medium and Deep Draw Presses do things faster. Rejects are virtually eliminated . . . present dies and materials can be used . . . one or more draws may be cut from a progressive operation, thereby saving man hours on the job . . . intermediate annealing is often reduced or eliminated and total production time cut down.**

**Designed for precision work and built for long service, these W-S Hydraulic Presses offer further advantages in set-up, maintenance and tool life. Available in a large choice of pumping units and controls. It will pay you to investigate their flexibility.**

**Other W-S Metal Working Presses include those for Forming, Flanging, Trimming, Forging, Coining, Hobbing, Extruding, Briquetting, Bending and Straightening.**







HYDRAULIC MACHINERY DIVISION

# WATSON-STILLMAN

Established 1848

**Factory and Main Office: 162 Aldene Rd., Roselle, New Jersey**

**Branch Office: 228 No. La Salle St., Chicago, Illinois**

REPRESENTATIVES

Birmingham 3, Ala. . . . . George M. Meriwether
Dallas, Tex. . . . . M & R Sales Co.
Denver 2, Colo. . . . . Overgard Machine Tool Co.
Indianapolis 20, Ind. . W. K. Millholland Mach. Co.
Los Angeles 11, Cal. . . . . H. M. Royal, Inc.
Pittsburgh 19, Pa. . . . . Stanley Berg & Co.
Portland, Ore. . . . . Machinery & Tool Supply Co.
Rochester 12, N. Y. . . . . Watson-Stillman Co.
San Francisco 7, Cal. . Schellenbach Mach. Tool Co.
Seattle, Wash. . . . Machinery & Tool Supply Co.
Spokane 8, Wash. . Machinery & Tool Supply Co.
St. Paul 4, Minn. . . . Anderson Machine Tool Co.

**Manufactured in Canada by—CANADIAN VICKERS, Ltd., Montreal**

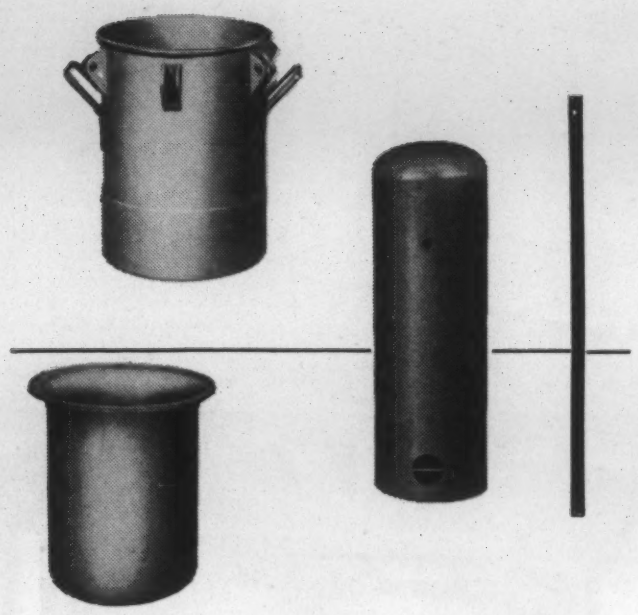
**W-S "COMPLETELINE" HYDRAULICS . . . THE SHORTEST DISTANCE FROM PRODUCTION TO PROFITS**

9-1-17

# Prest-O-Lite
Trade-Mark

## Cold-Drawn SHAPES and SHELLS

made to your specifications by *Linde*



**Leaders of the Field for Over 35 Years**

PREST-O-LITE cold-drawn shapes and shells can be quickly and economically produced to your most rigid specifications—from 1½ to 23 inches in diameter and up to 50 inches in depth. Our greatly expanded, well-equipped plant has every modern manufacturing facility and is manned by a thoroughly experienced, highly specialized staff—prime requisites of a quality product.

LINDE engineers will gladly help you solve your production and design problems involving cold-drawn shells, cups, containers, receivers, pressure vessels, formed parts, or other shapes.

The term "Prest-O-Lite" is a trade-mark of Union Carbide and Carbon Corporation.

LINDE AIR PRODUCTS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
30 E. 42nd St., New York 17, N. Y. UCC Offices in Principal Cities
In Canada: DOMINION OXYGEN COMPANY, Limited, Toronto

Linde Air Products Company S-22
30 East 42nd Street
New York 17, N. Y.

Please send complete information about cold-drawn shapes and shells.

NAME_____

COMPANY_____

ADDRESS_____


# New Materials and Equipment

and the table is said to easily handle work weighing up to 1 ton. Its feed rate is variable to 18 fpm with rapid return, and it slides easily over 28 rollers actuated by hydraulic pressure up to 200 lb, psi. Both work feed pressure and rate of travel are controlled and governed by material machinability for protection and conservation of the band tool being used.

Utilizing the newly developed diamond and line grinding bands in addition to standard Precision and Buttress saw bands and abrasive polishing bands up to 1 in. in width, as well as file bands of various shapes and cuts in ¼-, ⅜-, and ½-in. width, and a wide assortment of band tools for machining every type of material, the unit is also claimed to include the following features: built-in welder for joining saw and line grinding bands, job selector dials, and combination spray or flood coolant system complete with hydraulic operation and control.

# Testing & Control

## Rotor Temperature Recorder

An electronic recorder for accurately and quickly measuring temperature of the rotor in large electric generators has been developed by the *Brown Instruments Div., Minneapolis-Honeywell Regulator Co.*, 2841 Fourth Ave., S. Minneapolis.

Designed to provide a better and more economical instrument to assist operators in avoiding overloads, the Electronik furnishes a 12-in. strip chart record which can be used as a guide for gradually cooling a generator.

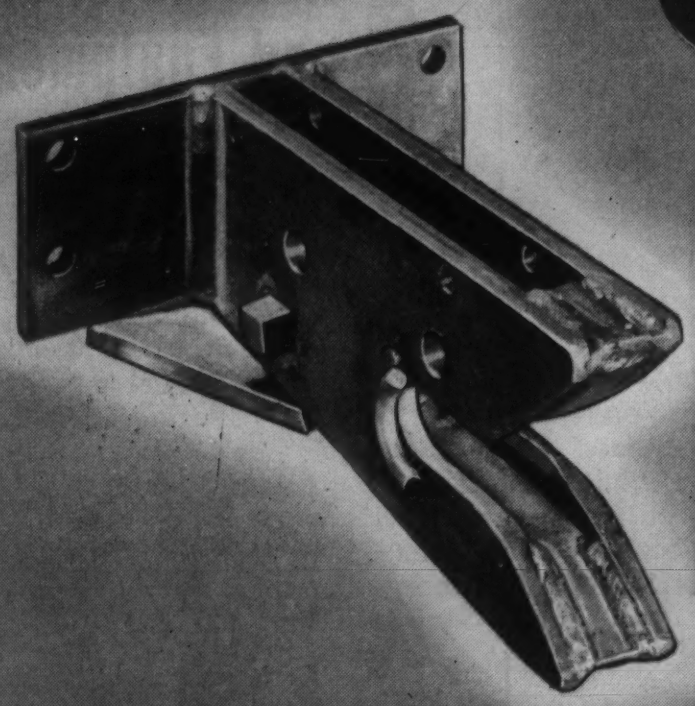
Other features of the new recorder are said to include:

1. A range of 0 to 15 degrees C.
2. A limit error of 1.5 degrees C.
3. A dead zone of 0.3 degrees C.
4. Pen speed of 1.4 min. full scale.
5. 0.1 to 4.0 ohms range of rotor winding resistance.
6. Dielectric test of 1500-v rms for 1 min.

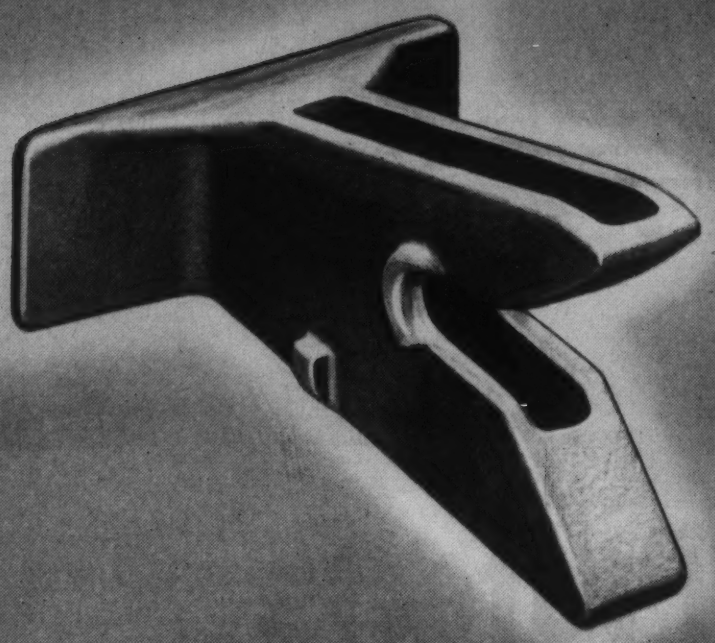
## Metal Analysis Unit

Developed to make possible a rapid, low cost method of structural analysis of metal

PRODUCT DESIGN STUDIES • NO. 26



*Fabricated* COUPLER HOUSING



*Cast Steel* COUPLER HOUSING

**Costs Reduced 25%**
**Performance Improved**
**Appearance Improved**
**with STEEL CASTINGS**

This warehouse trailer coupler housing is subjected to considerable stress and strain in handling materials for general factory use. As a weldment, it not only used 40 inches of welding, slowing down unit production, but lacked eye appeal.

Conversion to a *foundry engineered* steel casting, through cooperation of manufacturer and steel foundry, cut production costs 25%, improved trailer performance, and provided a streamlined appearance which added "saleability" to the product.

* * * * *

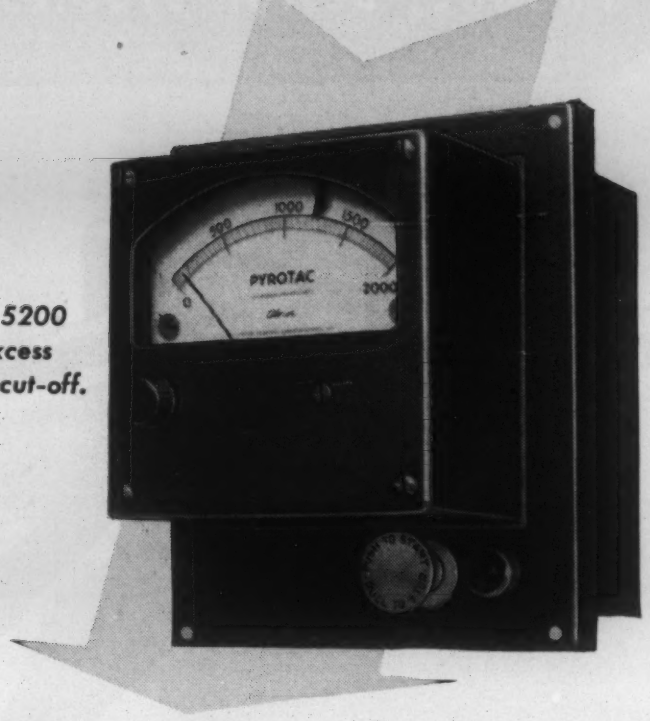
Here is another example of the engineering teamwork in design and redesign of parts which is resulting in greater serviceability and lower costs with steel castings.

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by the Steel Founders' Society of America.

**STEEL FOUNDERS' SOCIETY OF AMERICA**
**920 Midland Building** **Cleveland 15, Ohio**

Design and Build With Steel Castings

# Heating Safety




*Alnor Type 5200 Pyrotac excess temperature cut-off.*

# Protects

## Your Investment

**The Alnor Pyrotac excess temperature cut-off offers you low-cost, automatic protection against damage due to excessive temperatures . . . safeguards your investment in heating equipment and materials in process.**

**Simple in operation, the Pyrotac constantly indicates temperature of the heater equipment and stands ready to sound an alarm and/or shut down heater circuits at a pre-set maximum safe temperature. It may also be used as the only control instrument on a process that requires a complete shut-down upon reaching a final temperature. Automatic thermocouple break protection assures safety in the event that thermocouples or extension wires should break or burn out.**

**Small size, simple wiring makes it easy to install the Pyrotac on existing control panels. Available in scale ranges from 0°-600°F. to 0°-3000°F. and equivalent Centigrade ranges.**

**Here is another Alnor quality instrument featuring Alnico magnet, double air gap movement . . . laboratory precision and husky construction; yet the price is only . . .**

**$85** *far lower than for ordinary instruments of this type*

***Ask your Alnor Representative for complete details or write for bulletin that contains full description and wiring diagrams that show actual applications.***

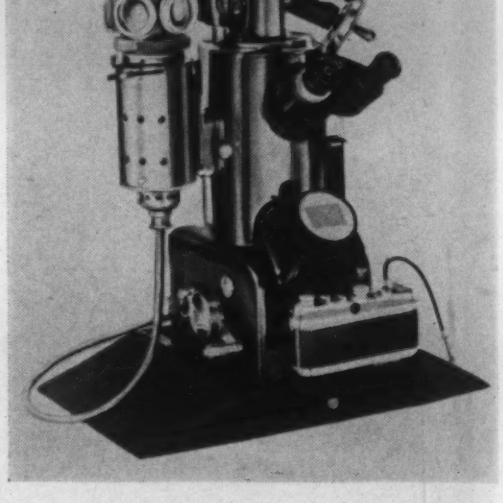
Alnor

**Illinois Testing Laboratories, Inc.**
**Room 522, 420 N. La Salle St., Chicago 10, Illinois**

**PRECISION INSTRUMENTS FOR EVERY INDUSTRY**


# New Materials and Equipment

samples and other substances with speed and accuracy, the new Metallograph offered by *F. T. Griswold Manufacturing Co.*, Wayne, Pa., is said to provide every



*Lenses used with this Metallograph are quickly inserted and removed and need no centering.*

facility for examination, study and photographic reproduction.

Extremely compact, occupying a table space of less than 12 by 12 in., the OPL Metallograph features a large assortment of objective, ocular and projective lenses and controls for fast, positive manipulation of all variables.

## Multi-Station Thermocouple Gage

An inexpensive vacuum gage in multi-station form for coaters, dehydrators, vacuum furnaces and other industrial high vacuum equipment has been announced by *Distillation Products Industries*, a division of *Eastman Kodak Co.*, Rochester 4, N. Y.

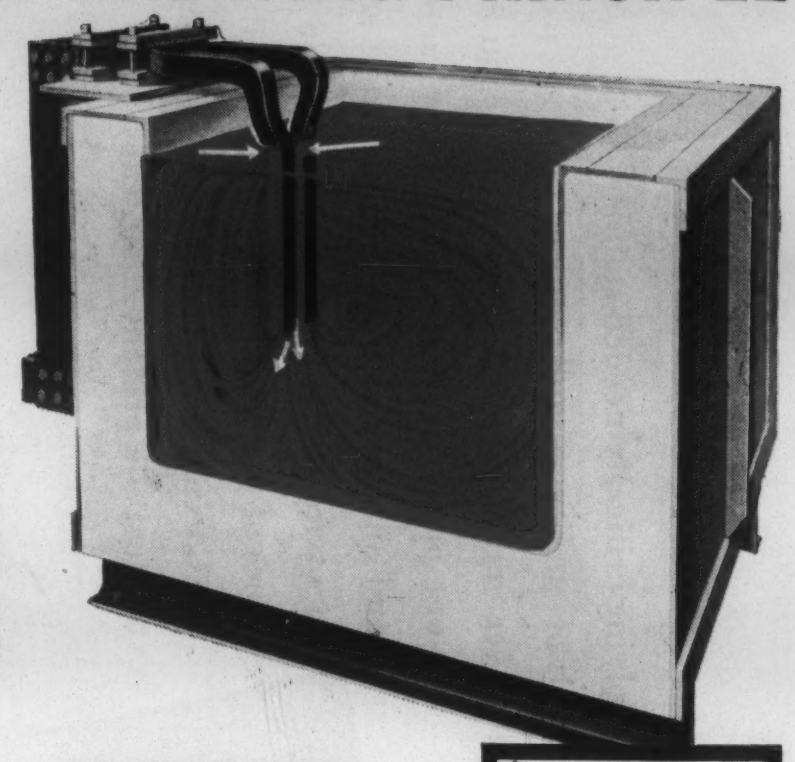
Designated as the thermocouple gage, type TG-09, the unit is available with 2, 3, 4, 5 or 6 stations, all reading on a single meter.

According to the manufacturer, the gage is extremely simple to use, requiring only that the operator turn it on and read the pressure. Range covered is from a few microns to one millimeter mercury. More than half the range of the indicating needle is devoted to the region below 60 microns.

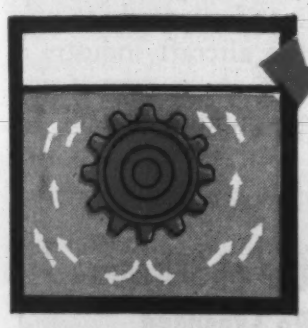
The multi-station gage and the previously available single-station gage, Type TG-02, operate from 115-v, 60-cycle lighting circuits. Also available is a single-station gage, Type TG-08, which operates from two flashlight dry cells.

# THE MOST EFFICIENT HEAT TREATING PRINCIPLE

*...for* CARBURIZING • CYANIDE HARDENING • NEUTRAL HARDENING • ANNEALING OR HARDENING STAINLESS STEEL • BRAZING • HARDENING HIGHSPEED STEEL • AUSTEMPERING • MARTEMPERING • PROCESS ANNEALING • CYCLIC ANNEALING • DRAWING (TEMPERING) • SOLUTION HEAT TREATMENT • DESCALING • DESANDING • CLEANING

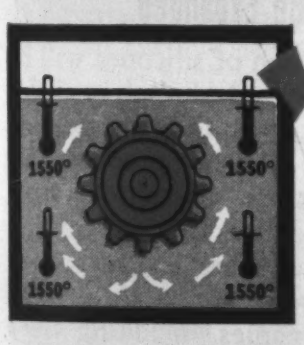


In the Ajax Electric Salt Bath, utilizing immersed electrodes, all heat is generated within the bath itself—the liquid salt acting as a "resistor". Electrodynamic forces produce vigorous circulation throughout the bath, in the *downward* motion indicated. This is precisely opposite to the *upward* thermal flow—dependent on a temperature difference in a bath—which exists in other salt bath furnaces. Only Ajax offers electrodynamic circulation!



## RAPID HEATING BY CONDUCTION

The rate of heating depends only on the heat conductivity of the work itself. Thus, the Ajax Salt Bath Furnace heats work 4 to 6 times faster than a radiation type or forced convection furnace.




## UNIFORM HEATING

The liquid salt completely surrounds the work and the automatic stirring action transmits uniform heat to all surfaces simultaneously. No other method delivers such heating uniformity—within 5° F. or *less* at any part of the bath.

## NO ATMOSPHERE PROBLEMS

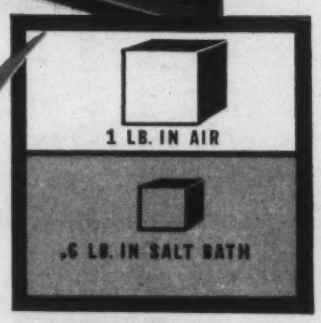
The Ajax Electric Salt Bath Furnace eliminates *all* atmosphere control problems. Scaling, oxidation and decarb are avoided. First cost of gas generating equipment as well as its operating expense are eliminated.

## AUTOMATIC PREHEATING

When a cold piece of metal is immersed, a "cocoon" of frozen salt forms around it instantly. This layer serves as a temporary insulator, preventing temperature shock and too sudden heating. The frozen salt melts in a minute or less and the work then heats rapidly to bath temperature.

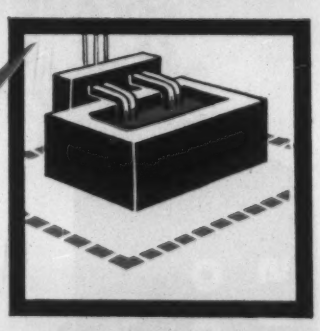
## BUOYANCY THAT MINIMIZES DISTORTION

Although the work sinks readily into the liquid salt, the bath nevertheless supports it to a marked degree. In effect, the work weighs appreciably less when immersed and this tends to prevent distortion and warpage.



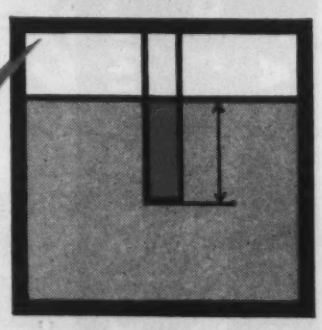

## MORE PRODUCTION IN LESS FLOOR SPACE

Because an Ajax furnace heats work so much faster—and because it eliminates the need for atmosphere generators and similar bulky auxiliary equipment, a proportionately smaller amount of floor space is required to handle a given volume of work.



## SELECTIVE HEATING

Because of its rapid heating rate, only that portion of the work immersed in the bath is heated. Just dip and treat *any desired portion* of any metal part or assembly.



## NO SKILLED LABOR

Operation is so entirely automatic, so closely controlled by the Ajax furnace itself, that even an unskilled operator can handle full production.

***72 pages of factual heat treating data! Write for Catalog 116 on your company stationery.***

# AJAX ELECTRIC SALT BATH FURNACES

HULTGREN

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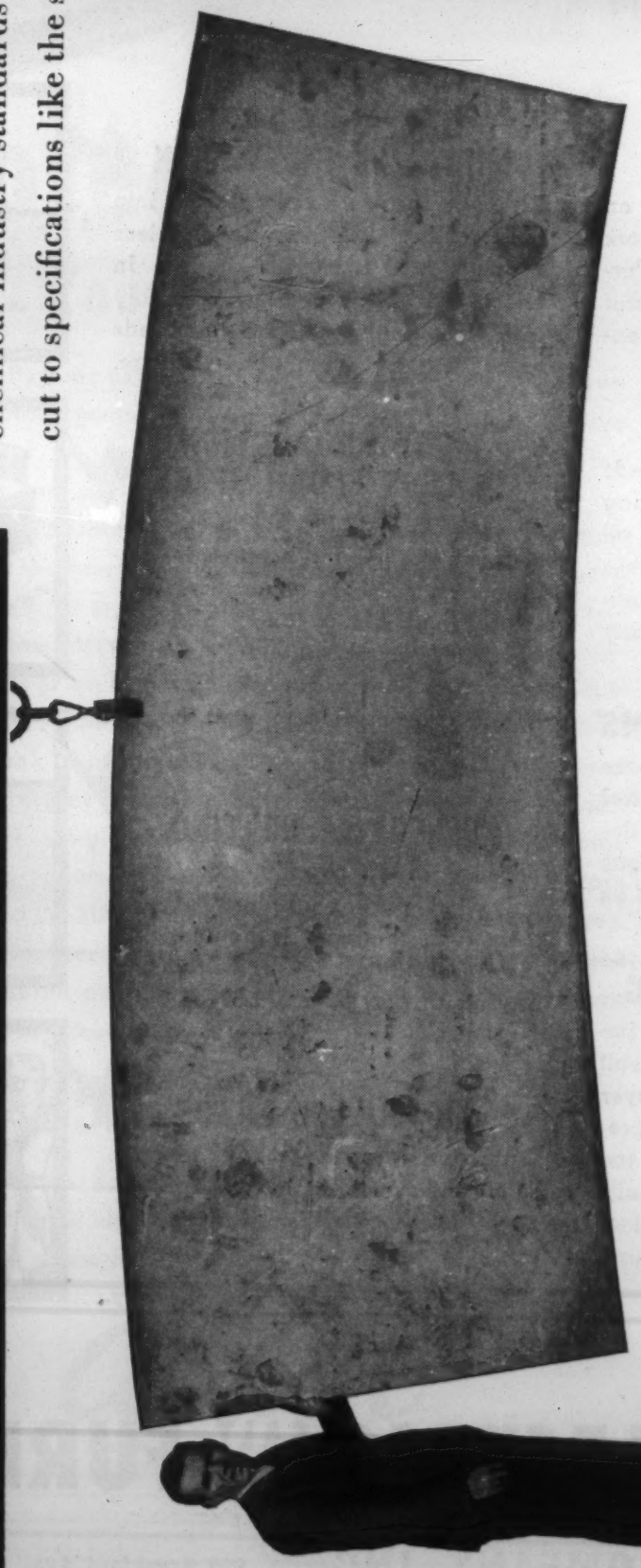

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# News Digest

## High Strength Aluminum Alloy

(continued from page 13)

forces, and the aircraft industry, the alloy — temporarily designated "XA78S"—is being made available to plane builders for experimental and controlled production use only. For the present the new alloy will be confined to the production of sheet, plate and for extrusions.

It was developed by modifying the same alloy constituents that were successfully combined to produce Alcoa alloy 75S, designed expressly to meet the needs of the aircraft industry in 1944. Alloy 72S is a copper-zinc-magnesium type composition.

## Production of Silicones to Be Expanded

The production of silicones will be expanded here and abroad in 1951, it was forecast by R. O. Sauer, Section Engineer on silicone products for General Electric's Chemical Dept., speaking before the Chicago Section of the American Chemical Society.

At the present, in the U. S. there are three companies, including General Electric, actively manufacturing silicones on a sizable scale. It is estimated that these companies manufactured several thousand tons of silicone products last year, and, in common with many other segments of the chemical business, will expand their production considerably in 1951.

Also a factor in forthcoming production increases in silicones is the indication that additional U. S. concerns may soon be manufacturing, or at least pilot-planting, similar products, Mr. Sauer stated, and it seems certain that additional production facilities will soon be available in Europe.

## Ceramic Coatings Prevent Exhaust-Gas Corrosion

An investigation of the corrosive effects of lead bromide vapors on various heat resistant alloys, both with and without protective ceramic coatings, has recently been completed

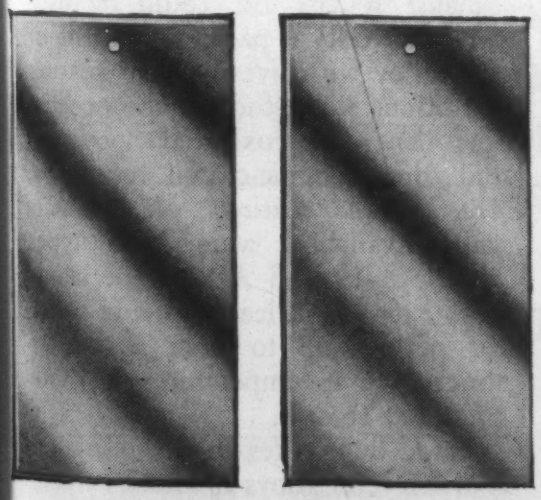
# New Materials and Equipment

## Clear Coatings for Zinc and Steel Stand 800 Hours' Salt Spray

Increased use of zinc die castings and of zinc-plated steel to replace unavailable materials, combined with the tight supply of copper, nickel and chromium normally used for plating zinc, has focused attention on surface coatings comparable to plating in service performance. Unbiased laboratory tests show that at least two of the clear finishes in the company's line withstand the exceptionally long period of 800 hours' exposure to salt spray and to weatherometer tests.

### Effectively protect zinc

These tests demonstrate that DULAC Clear Universal Lacquer #462 and CODUR Clear Synthetic Y743 provide completely satisfactory protection on zinc, zinc plated steel and steel. Even after the unusually severe tests to which these finishes were subjected, there was no indication whatever either of failure of the coating or of discoloration of the zinc.



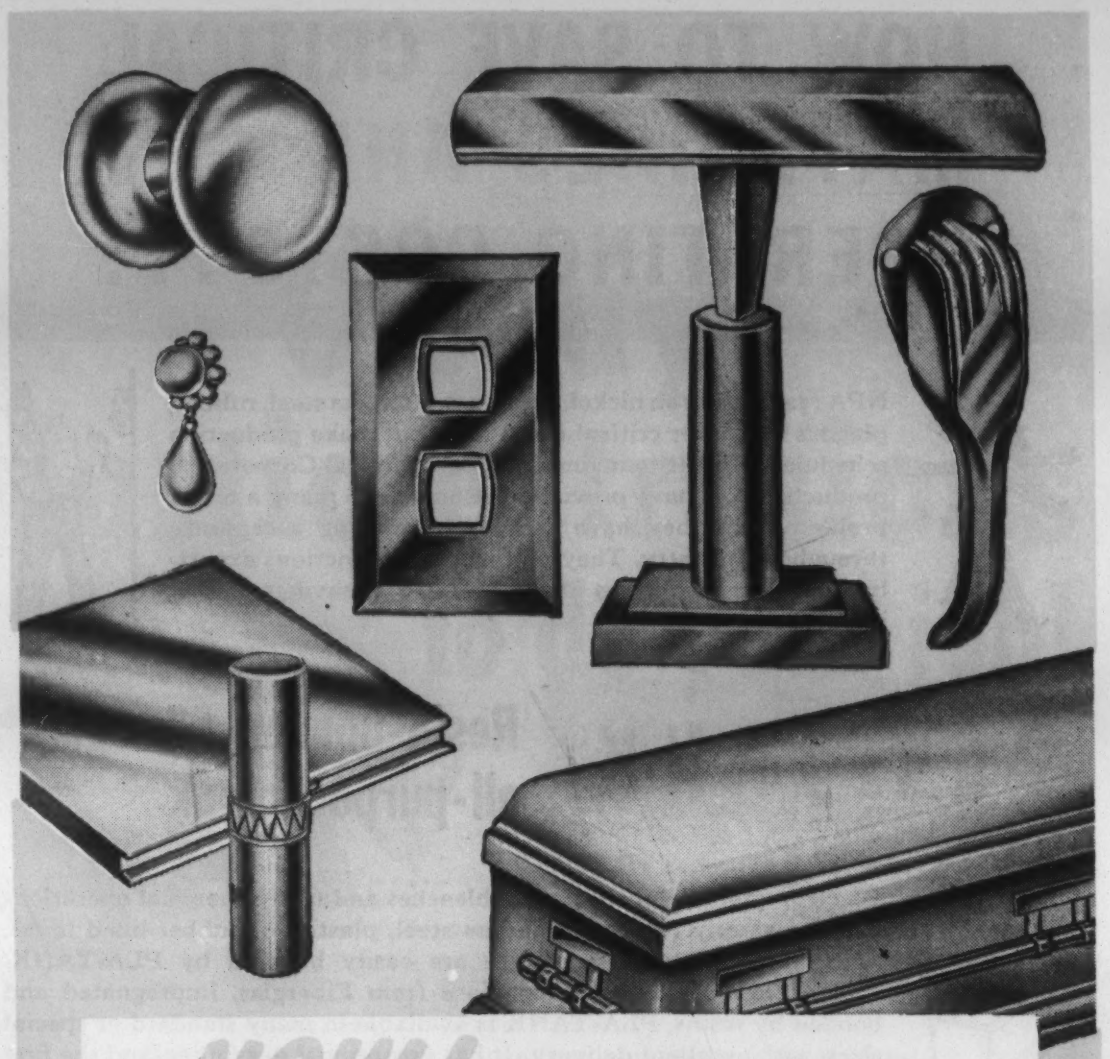
*(Left) A zinc-plated steel panel newly coated with DULAC #462. (Right) A similar panel after 800 hours' exposure to salt spray, showing no evidence of attack on the finish.*

### Adaptability to Drying Schedules

While both finishes give the same performance, DULAC #462 is an air-drying coating, while CODUR Y743 is a baking type. This permits choice of the correct finish to fit into the drying schedules of a particular finishing room.

Technical Data Bulletin #110 on clear finishes is available from Maas & Waldstein Co., 430 Riverside Avenue, Newark 4, N. J. On request, M & W Technical Service Engineers will discuss specific problems.

(Adv.)

NOW! simulate copper, brass and bronze on products like these with

M&W PLATELUSTRE

Don't let critical metals put a *needless* crimp in your production!

Take zinc or steel—apply a coating of one of the new PLATELUSTRE finishes. You wind up with products and parts that look so much like copper, brass and bronze that *the eye can scarcely tell the difference!*

Whether you have been using now unavailable copper and its alloys for *making* products or for *plating* products, you will find these new M & W finishes *equally* effective in keeping your plant running. There are types for air-drying and baking schedules — pick the one that best fits *your* production requirements.

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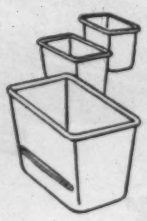
MANUFACTURERS OF INDUSTRIAL FINISHES

# HOW TO SAVE CRITICAL MATERIALS AND CUT OPERATING COSTS . . .

NPA restrictions on nickel, cadmium, stainless steel, rubber, plastics and other critical items need not make production schedules difficult to maintain. The Chemical Corporation products below have provided the answer to many a tough problem, and they have met with amazing acceptance throughout industry. They perform their functions expertly, and their use brings about operational savings of real importance.

## PLA-TANK® Resin-bonded Fiberglas® all-purpose tank



Electroplaters' solutions, acids, bleaches and many chemical operations which formerly required stainless steel, plastic- or rubber-lined tanks, crocks or acid-proof stoneware are easily handled by PLA-TANK. Molded in a single seamless piece from Fiberglas, impregnated and bonded by resins, PLA-TANK is available in many standard or special sizes, with excellent delivery. It has exceptional durability, and the first cost is lower than for most other suitable materials. Write on your letterhead for a sample panel.

## LUSTER-ON® Utility zinc dip saves nickel and cadmium

The original passivating cold bright dip for zinc, with great resistance to stain, tarnishing with age, or white powder corrosion products. Does not impair electrical conductivity or interfere with spot welding, and forms an excellent adhesive base for lacquers and cements. It gives to zinc plate an aging resistance and appearance superior to cadmium at lower cost — as little as 1/5¢ per square foot, since it can be diluted up to 10 times with water. Send sample parts for finishing at no charge.

## KHAKI DRAB Luster-on; 300-hour salt spray resistance

Far exceeds U. S. Government specifications of 96 to 100 hours salt spray resistance. This chromate type conversion coating has been developed primarily for electro-deposited zinc plate, although the same dilutions (7 to 10:1) are equally effective on cadmium. It imparts a very high protection against corrosion, and acts as an excellent paint bond for later organic finishes. Diluted one part Khaki Drab with seven parts water, a light iridescent khaki color results; diluted with 10 parts of water, the color is a rich khaki bronze tone. Sample parts finished at no charge. Address inquiries to

THE *Chemical* CORPORATION

60 Waltham Avenue • Springfield 9, Massachusetts


# News Digest

at the National Bureau of Standards. The NBS investigation demonstrates that the uncoated alloys corrode fairly rapidly when exposed to lead bromide vapors at high temperatures, but that certain ceramic coatings effectively prevent corrosion under the same conditions. Sponsored by the National Advisory Committee for Aeronautics, the studies were conducted by Dwight G. Moore and Mary A. Mason, of the NBS Enameled Metals Laboratory.

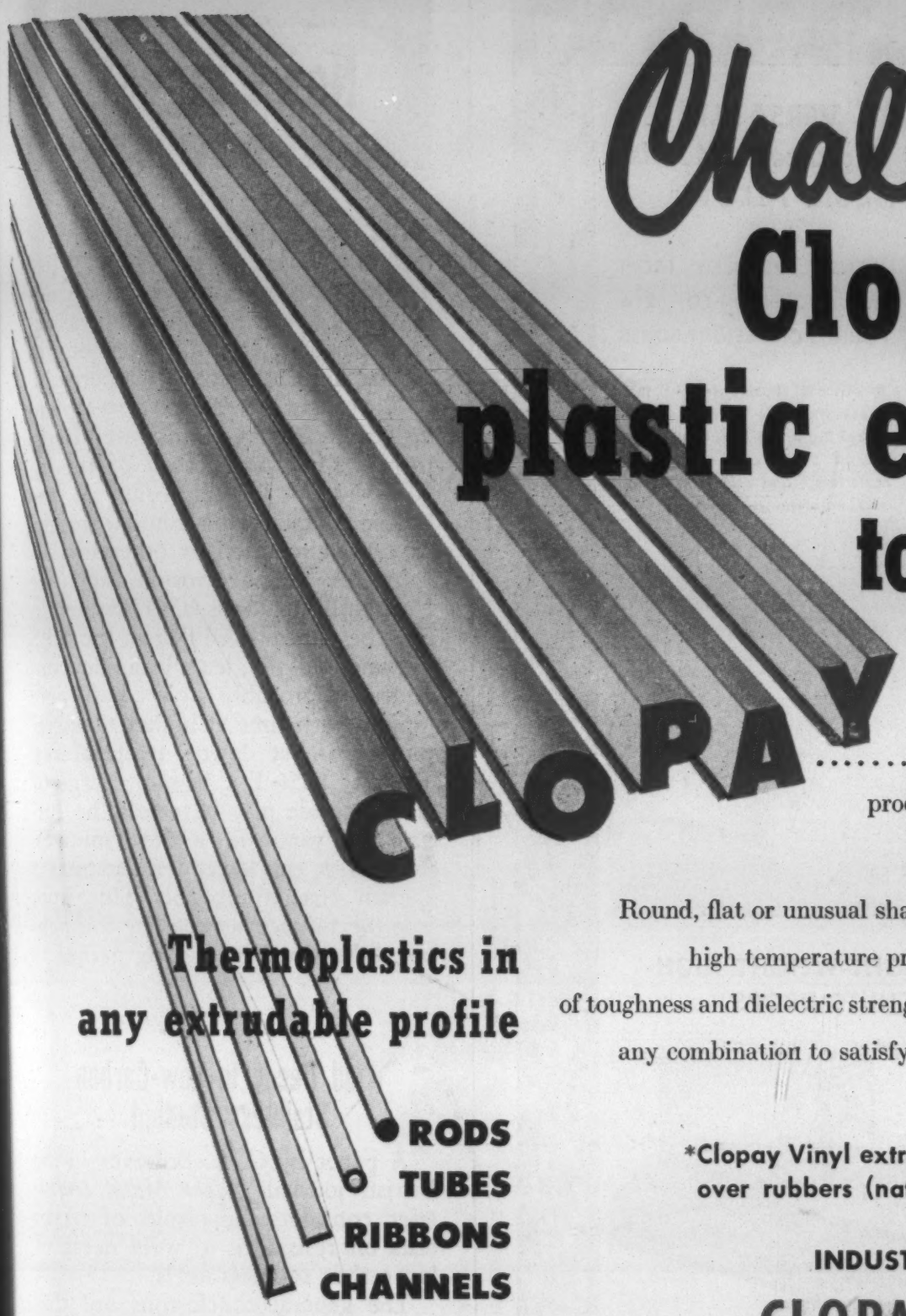
Lead bromide is present in the exhaust gases of all engines that use leaded gasoline as a fuel. Aviation gasoline is more heavily leaded than automobile fuel, however, and aircraft exhaust temperatures are higher. For these reasons, corrosion from lead bromide is a greater possibility in aircraft than in automobiles.

Five heat resisting alloys were investigated by NBS: Inconel (a high nickel alloy), types 347 and 19-9DL stainless steels, Vitallium, and S-816. The first three alloys are in regular use in exhaust systems. Vitallium and S-816 are turbine blade alloys and, although too expensive for general exhaust system use, could be used for small critical parts. Specimens of each alloy with five different coating conditions were studied: an uncoated specimen, a preoxidized specimen, and three ceramic-coated specimens. The ceramic coatings, all commercially available, were NBS types A-417, A-19 and A-520. Specimens were exposed to lead bromide vapor for periods up to 6 hr in an air atmosphere at temperatures of 1350, 1500 and 1650 F.

Large differences in the resistance of the several alloys to attack by lead bromide were found. although all five uncoated alloys suffered corrosion at all test temperatures, the loss of thickness in the full 6-hr period ranged from 1.2 to 10.1 mils. Alloys S-816, Vitallium and Inconel were notably more resistant than the 19-9DL and type 347 stainless steels, both of which are high-iron, austenitic-type alloys. Microscopic examination indicated that a selective attack took place with the 19-9DL and 347 steels, leaving a spongy layer near the surface. With the other alloys, however, very little selective penetration was found.

Preoxidation of the surfaces of the

*(Continued on page 148)*

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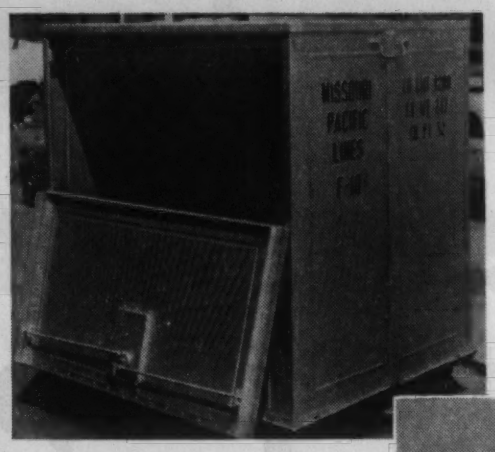

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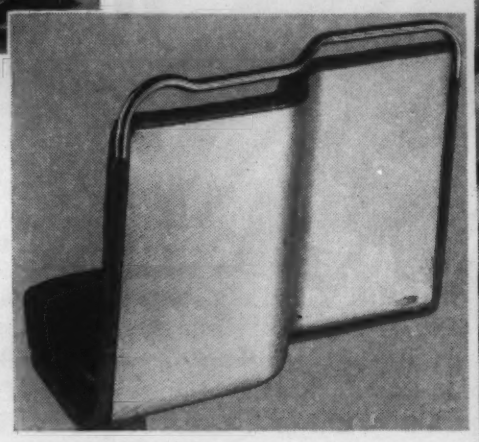

**RIGIDIZED METAL BUS SEAT BACKS ALLOW GAGE CUT FROM .037 to .018**

● Mar-resistant bus seat backs of Rigidized Metal (Pattern 5-WL) allow a gage reduction of 50%. This results in a substantial saving of strategic alloys.

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● To protect delicate X-ray equipment during parachute drops and other rough service, the Army uses containers of Rigidized Metal (Pattern ACC4i). A reduction of weight, plus added strength and impact resistance, helped conserve metal.

**GAGE CUT OFF 33 1/3% ON RAILWAY COACH WAINSCOTING OF RIGIDIZED METAL**

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# News Digest

alloys tended to retard corrosion for the first hour or two only, after which corrosion proceeded at an undiminished rate. Preoxidation was accomplished by heating specimens in air for 4 hr at the test temperature.

No consistent relation was found between temperature and rate of corrosion; some but not all of the alloys showed less corrosion at the higher temperatures. Similar results have been reported by other investigators of alloy corrosion, and are apparently not unusual. However, it must be remembered that in the NBS test method the lead bromide concentration probably dropped off more rapidly with time at higher temperatures than at lower temperatures. Thus, at 1650 F a 1-gram charge of lead bromide may have left the furnace as vapor in a few minutes, whereas at the lower temperatures a 1-gram charge probably fed vapor into the furnace atmosphere throughout the entire 1-hr heating period.

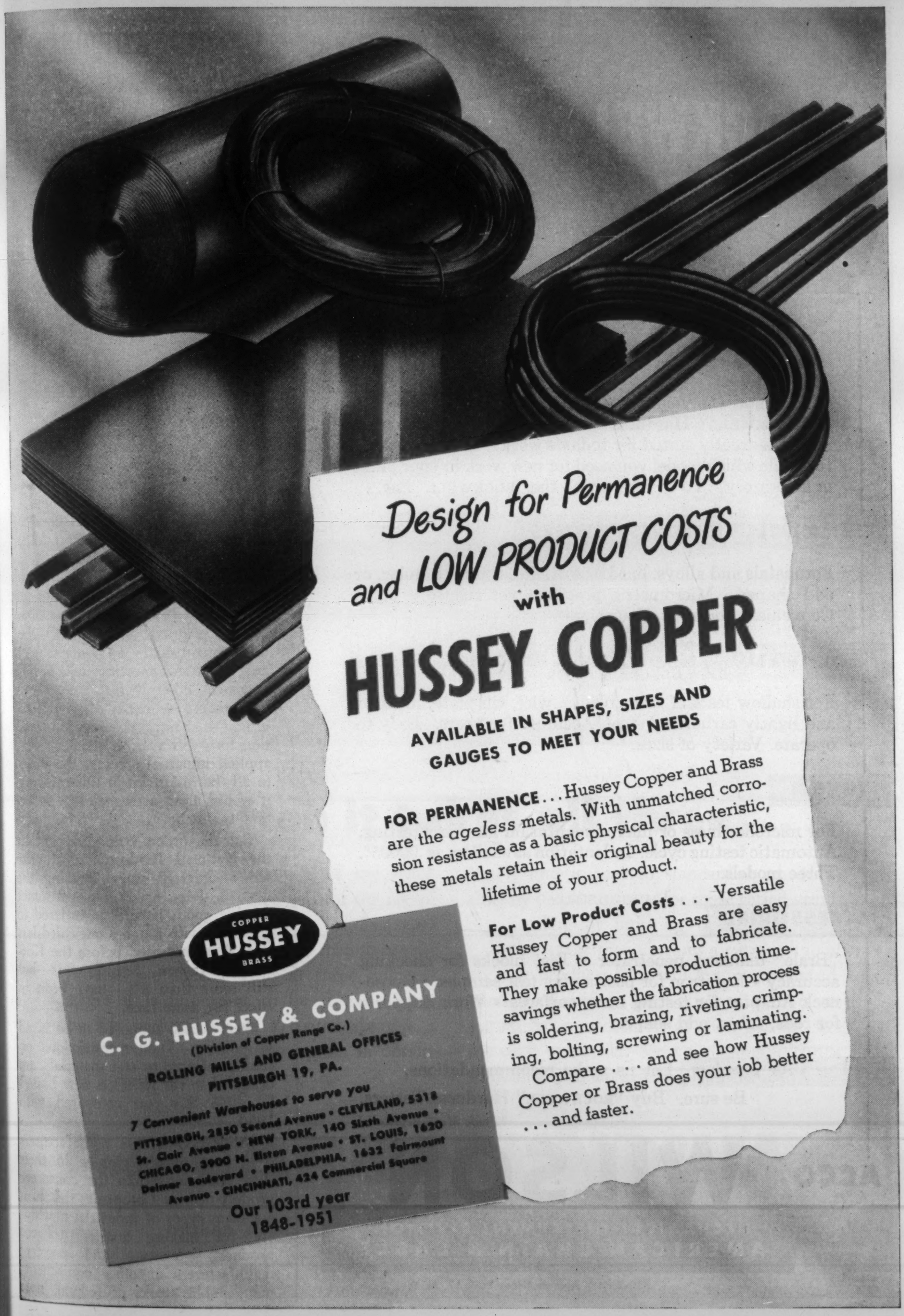
## Weld Decay in Low-Carbon Stainless Studied

A paper by G. R. Bolsover in the British journal, *Sheet Metal Industries,* considers the results of recent tests on resistance to weld decay of low carbon stainless steels.

The general conclusions are that whereas an 18:8 stainless steel, even as low as 0.08% in carbon content, collapses completely under standard conditions of testing, the 0.03% carbon 18:8 steels and also steels of somewhat higher carbon content, when treated with titanium, give perfect results so far as resistance to weld decay is concerned.

Under more severe conditions, the 0.03% carbon steel behaves similarly to the steel with 0.06 carbon and 0.31% titanium. It does not resist weld decay on the accentuated tests as well as the steel with a titanium-to-carbon ratio in excess of 8:1. However, this would indicate that where the standard conditions of testing have proved a satisfactory guide to behavior in service, there is no need for titanium or other inhibitors.

It is inadvisable to attempt to produce a stainless steel with a high polish by the addition of titanium. The low-carbon steel with similar re-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# News Digest

sistance to weld decay is very satisfactory from this point of view.

In mechanical properties, the tendency is to obtain a slightly softer steel with 0.03% carbon and a lower work-hardening factor than obtained with higher carbon steels. Slight variations in nickel and chromium content, particularly toward the lower limits of acceptable steels, will cause appreciable variations in hardness and ductility values.

## Consumer Goods Take Biggest Metal Cut

A close analysis of the Government's recently announced plans for parcelling out steel to industry shows that the biggest cuts have come in consumer goods. The makers of automobiles, appliances and other consumer durables have taken by far the biggest reductions. The purpose of these large reductions is not entirely to get more metal for defense.

The planners divided all steel users into three broad groups: military, defense-supporting, and an all-inclusive "others."

Non-defense users—the "others" group—is being cut only four million tons this year. If that cut were applied impartially across the board to all the industries in this category, it would mean a meager 8% reduction for each.

But the orders being put out by the National Production Authority tell a different story. Starting the first of July, makers of consumer durable goods have been ordered to get along with roughly one-third less steel than they used before the Korean war began. Smaller cuts—but still more than 8%—have been in effect for some time.

Steel is also supposed to be saved in housing. Tighter restrictions on credit, enforced to save materials, are designed to cut starts on new homes by 40% this year compared with 1950.

Other non-defense manufacturers have been more fortunate in their steel allocations than the consumer product makers. Companies that turn out many types of industrial machinery—for making textiles, tobacco products, glassware and pottery; manufacturers of office equipment; many public works of federal, state

# Often it takes all three...

A typical example of the many products which call for the use of not one...two...but *all three* types of abrasives in the manufacturing process are shears. Thus at three different stages it is important to be able to count on the performance of a coated abrasive, a bonded abrasive, or abrasive grain in obtaining best results.

You'll find it pays to standardize on Abrasives by CARBORUNDUM for these varied grinding, sanding or finishing operations. Only CARBORUNDUM manufactures a *complete* line of abrasive products from which you gain the advantage of uniform high quality...and an impartial recommendation of the *right* abrasive for each operation. See your CARBORUNDUM representative, or write Dept. MM 80-22.

## *Only* CARBORUNDUM

TRADE MARK

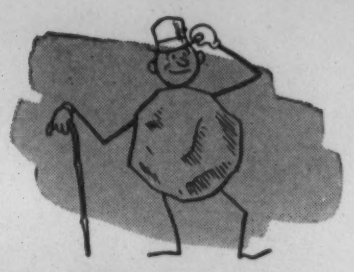
***makes ALL Abrasive Products... to give you the proper ONE***

*"Carborundum" is a registered trademark which indicates manufacture by The Carborundum Company, Niagara Falls, N.Y.*

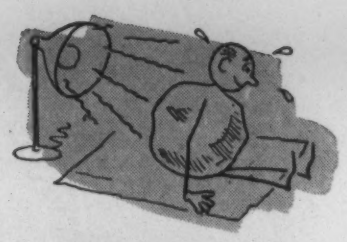
80-22

*For*

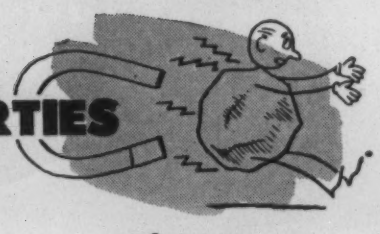
**GRAIN REFINEMENT**



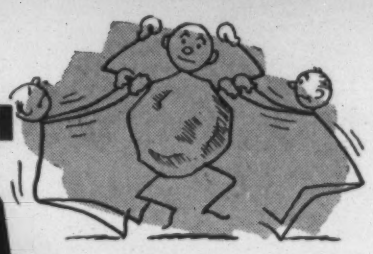
**HEAT TREATMENT**



**BETTER MAGNETIC PROPERTIES**



**HIGHER TENSILE STRENGTH**



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**TITANIUM or ZIRCONIUM**

**IN ALLOY OR SINTERED LUMP FORM**

If you have a problem in alloying with Ti and Zr — or trouble with the castings you produce with these alloys — then it's time now to discover how Metal Hydrides Incorporated can help you. Thanks to new techniques, MH produces Titanium and Zirconium (and many other metals and alloys) in commercial quantities in far more useful forms than ever before. For example:

**MH TITANIUM is available as —**

**TiCu** — A master alloy easily introduced by normal foundry practices. Assures high yield at comparatively low cost.

**TiNi** — If you work with nickel, and the addition of Ti for its tensile-increasing grain-refining qualities is a requirement, you'll get top results with TiNi. Readily miscible at normal furnace temperature.

**Sintered Ti** — Highly refined lumps for easy, fast, no-loss inclusions.

**. . . and MH Zirconium is available as —**

**ZrCu** — Forms age-hardening alloys without loss of heat and electrical conductivity . . . many other valuable uses.

**Sintered Zr** — Safe easy-to-handle form of Zr . . . introduced by regular furnacing procedures — gives extra quality to your Cu, Ni, or other alloys.

***These new MH metallurgical tools can help simplify your alloying problems. Find out how — write today outlining your problem.***

**6 big advantages when you use MH Titanium and Zirconium**

- Easy to handle
- Non-oxidizing additive
- Economical
- Use directly
- Fortify grain structure
- Refine grain structure

Titanium, Lithium, Aluminum, Zirconium, Tantalum, Sodium, Barium and Calcium Hydrides

**MH**

**METAL HYDRIDES INC.**
12-24 Congress Street
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# News Digest

and local governments; a lot of non-defense plant and commercial construction have made out pretty well.

Obviously, there are industries vital to the defense effort which aren't making guns or planes or tanks. But the Government controllers tend to throw more and more industries from the "others" category into the defense-supporting group. These industries, of course, don't support "defense" alone.

The group was already pretty broad when the steel chart was made up. It included companies building new steel and aluminum mills; materials-producing schemes, such as opening copper mines and drilling new oil wells; railroads and shipbuilders; power plants; machine tool manufacturers; and some repair and operating supplies to keep industry generally fit.

Since the chart was made up, it is apparent that even more companies and industries are climbing up into the favored defense class. The planners' chart indicates that the "military" and "defense-supporting" groups would take about 36% of the nation's steel this year. But the steel companies say they now have "defense" orders for over 40% of third-quarter finished steel production.

But the question has been raised as to whether the defense producers aren't getting more steel than they can use. Recently the President's Advisory Board on Mobilization Policy embarked on a study of this question.

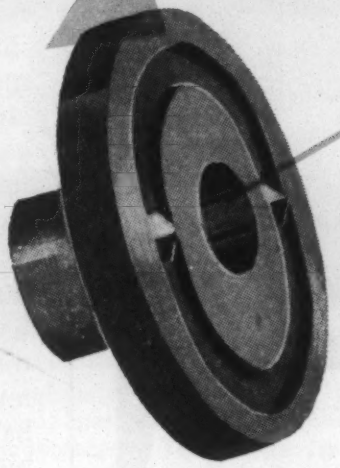
Defense agency heads are hinting that later on even more steel will be taken from consumer durables to be used in so-called "defense" industries.

## Cerium Increases Hot Workability of Steels

The Carpenter Steel Co., Reading, Pa., has unveiled a discovery which can increase the use of high-alloy, corrosion resistant, heat resisting steels formerly found to be impractical because of limited hot workability.

At least seven years in the development stage in Carpenter laboratories, the invention applies to ferrous alloys containing nickel and one or more of the elements chromium, molybdenum, cobalt, copper, tungsten, silicon, manganese, columbium

# How would you produce this part?



The part illustrated was made by The Wel-Met Co., Kent, Ohio

It's a small part for a Dictaphone Time-Master Dictating Machine . . . Dictaphone engineers tried machining the figure-8 cam groove and inserting two triangular rise-points. Too costly!

Then they tried casting in brass by the lost wax method. Unsatisfactory groove!

The irregular contours, changing radii, the rise-points in the cam groove, pointed to powder metallurgy as the solution of these complex difficulties.

The precision of this method is such that machining or finishing operations are often eliminated.

Tolerances as low as ±.003" are easily held; on some parts as close as ±.001". Production rates run as high as 50,000 per hour per press.

The pressing and sintering processes create novel alloys, as of copper with steel or copper with carbon . . . permit the combining of oil and metal to give long self-lubricating bearing life . . . cut costs of many parts to a fraction of what they would be by machining, casting, forging, stamping.

Stokes engineers . . . designers and builders of the presses on which powder metal parts are made . . . will gladly consult with you on the suitability of your parts for powder metal production . . . or on their re-design to adapt them to this money-saving method.

**STOKES**

**STOKES MAKES**

**Plastics Molding Presses,**
**Industrial Tabletting**
**and Powder Metal Presses,**
**Pharmaceutical Equipment,**
**Vacuum Processing Equipment,**
**High Vacuum Pumps and Gages,**
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**F. J. STOKES MACHINE COMPANY, 5972 TABOR ROAD, PHILADELPHIA 20, PA.**

WITH

# HITCHINER

PRECISION INVESTMENT CASTINGS

*COST* IS REDUCED

*QUALITY* IS MAINTAINED

*PLANT CAPACITY* IS INCREASED

for G. L. Brownell, Inc., Worcester, Mass., manufacturer of gear driven twisting machinery for textile mills since 1881.

ACTUAL SIZE

"This company is always anxious to keep the quality of its product up but equally desirous to utilize any new techniques to keep the price of its product as low as possible.

The part shown above, known as a Traverse Head, for many years was machined from a bronze sand casting. Recently this part was changed to your precision investment casting in manganese bronze.

Two advantages have resulted. The cost of the piece has been reduced while maintaining the quality, and productive capacity of the Brownell shop has been increased due to removing this part from its production."

From a letter from Carl R. Brownell, President, G. L. Brownell, Inc.

Added to all these advantages is the improved appearance inherent in precision investment castings. Ask Hitchiner how to solve your investment casting problems.

Send your drawings for complete engineering analysis and recommendation.

To learn more about Hitchiner precision investment castings send for this free informative folder.

## HITCHINER Manufacturing Company, Inc.

MILFORD 3, NEW HAMPSHIRE

Sales Office: 967 Farmington Ave., West Hartford 7, Ct. Representatives in principal cities.

# News Digest

and vanadium. Heretofore, a principal obstacle to the full utilization of the advantages offered by these alloys has been the difficulty or practical impossibility of forging and rolling them into desirable shapes, like sheets, rods and tubes.

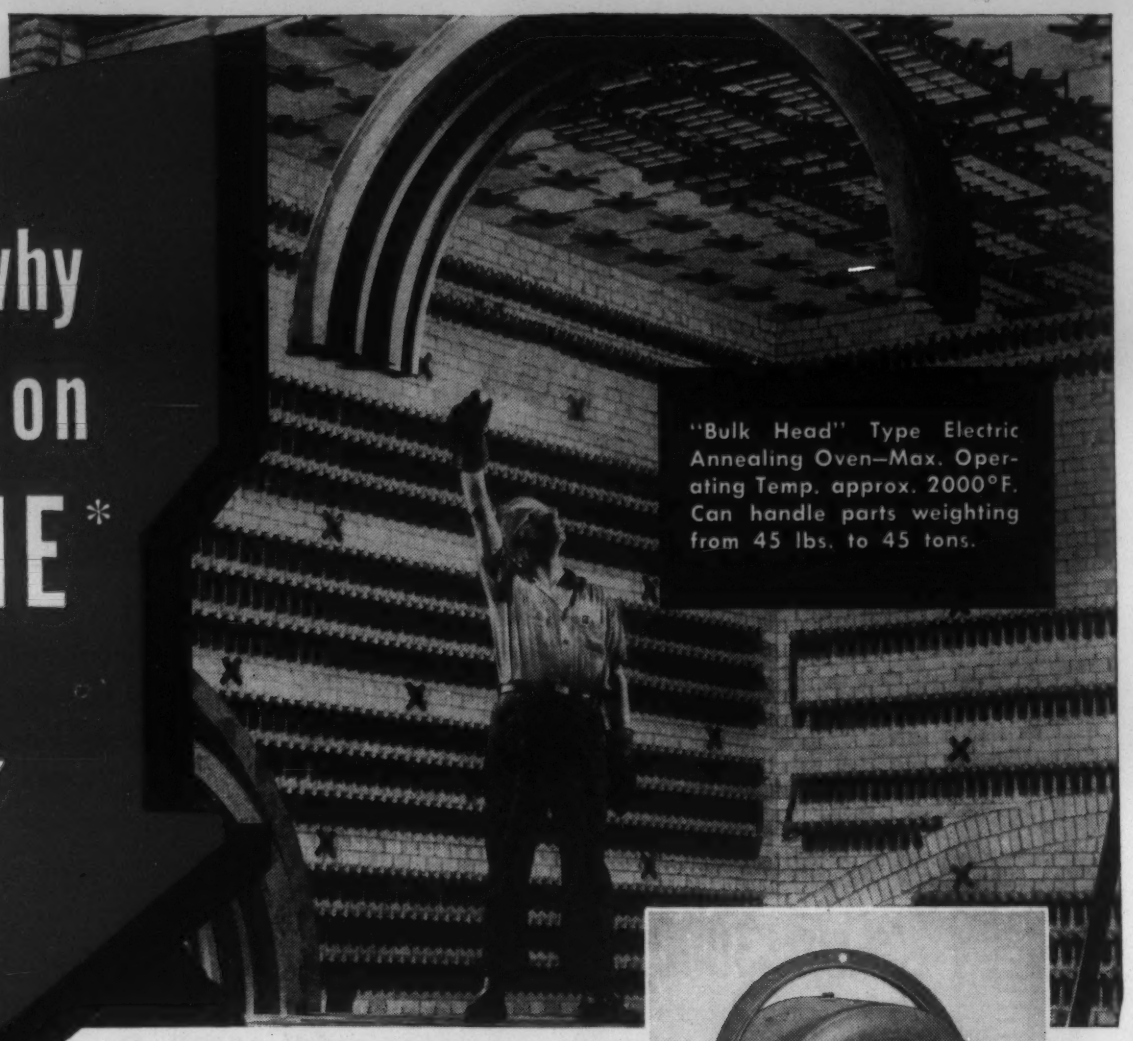
Previously, the chief uses of cerium and its compounds have been found in cored carbon for flaming arcs, in flints for cigarette lighters, and in the ceramic industry. The principal source of cerium and lanthanum is monazite sand. The supply of cerium and lanthanum recently has received a boost because of the intense interest in certain heavy elements so vital to the production of atomic energy. Some of these heavy elements can be obtained from thorium, which is found in some monazite sands.

Pure cerium or pure lanthanum can be used separately, but Carpenter has discovered that combinations of the two metals within certain minimum and maximum proportions have been found effective. The combinations are found in misch metal, the major part of which consists of cerium and lanthanum. It was found that the nickel content of any of the alloys of this invention determines the minimum and maximum allowable ranges of cerium and lanthanum which will produce hot workability. It was further discovered in Carpenter laboratories that as the nickel content increases in any of the alloys, the allowable range of cerium and lanthanum which can be used to promote workability is narrowed. The invention applies not only to ferrous alloys containing more than 50% iron, but also to nonferrous alloys containing little or no iron.

## Production of Larger Plastic Parts Predicted

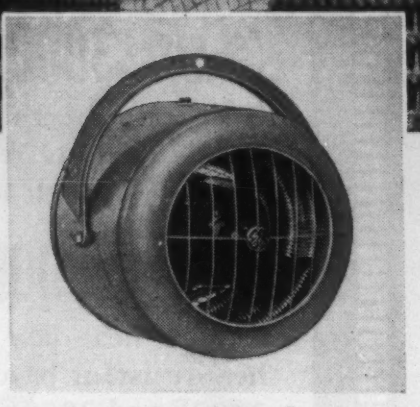
Complete refrigerator interiors, kitchen cabinets, and new type fluorescent lighting fixtures molded in one piece from plastics may some day be rolling off production lines, according to General Electric Chemical Dept. officials. This predicted invasion of large plastics parts into the consumer and industrial field will be made possible by recent de-

# 5 reasons why you can rely on NICHROME* in your electrically heated products



"Bulk Head" Type Electric Annealing Oven—Max. Operating Temp. approx. 2000°F. Can handle parts weighting from 45 lbs. to 45 tons.

*(Photographs courtesy of General Electric Company)*



Forced-Convection Type Unit Air Heater.

1. Nichrome alloys, meticulously developed over a period of 40 years, meet the need for resistor materials that can perform with exceptional suitability at high temperatures. Their high resistivity and resistance to oxidation at high temperatures dictate their choice for heating elements in a host of different products.

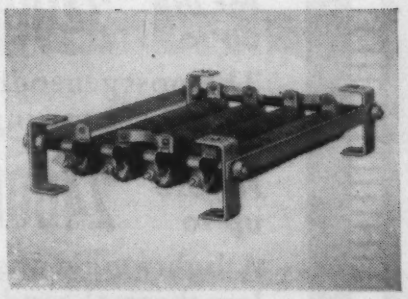
2. Nichrome and Nichrome V are *custom built*—produced to rigid specifications determined by conditions of application and in-use factors. Consequently, *absolute uniformity* is assured from order to order.

3. Nichrome and Nichrome V undergo only negligible changes even when required to meet unusually exacting service demands. Thus delivery of full-rated power is assured thruout a long life of trouble-free operation.

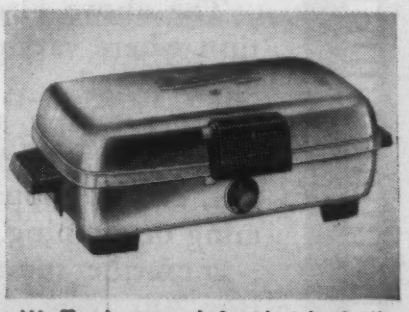
4. Nichrome and Nichrome V afford flexibility of choice, permitting heating elements to be designed economically, with close regard to service requirements. For example: Nichrome is ideal for heating devices, such as cord-connected domestic appliances, operating up to 1700°F.; Nichrome V for electric furnaces, ovens, etc., operating at temperatures in excess of 1700°.

5. Nichrome and Nichrome V are available in different forms—wire, ribbon, strip, sheet and rod. Such variety offers outstanding aid to designer, engineer, and manufacturer.

The different examples of products shown here indicate the wide range of application for Nichrome and Nichrome V. For improved performance and longer life in *your* products, remember these peerless Driver-Harris electrical alloys and consult with us. Although the present emergency is making unprecedented demands upon the resources of the Driver-Harris Company, we shall be glad to make recommendations based upon your specific needs, and serve you to the best of our ability.



Edgewise-wound resistor—typical of large industrial applications.



Waffle Iron and Sandwich Grill —one of many G.E. appliances.

Nichrome and Nichrome V are manufactured only by

## *Driver-Harris Company*

**HARRISON, NEW JERSEY**

**BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco**

Manufactured and sold in Canada by The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

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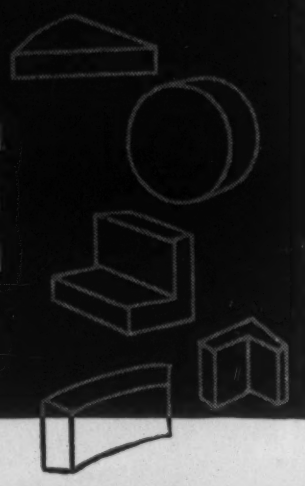
CAST SPECIAL SHAPES QUICKLY . . . EASILY

*... with these*

# FIRECRETE

## Castable Refractories



Check the job to be done and you will find a Firecrete* product that will do it well. For special refractory shapes or linings it's simply mix and cast. The new shape or lining air-hardens and is ready for service within 24 hours. Other advantages include—no drying shrinkage, negligible firing shrinkage, high resistance to spalling.

***For use up to*** **3000F — 3X FIRECRETE**

This new member of the Firecrete family effectively withstands soaking temperatures up to a full 3000F. Provides savings through longer life and reduced shutdowns.

***For use up to*** **2800F — H-T FIRECRETE**

A high heat-duty refractory composed of an exceptionally heat-resistant base. Specially developed for service between 2400F and 2800F.

***For use up to*** **2400F — STANDARD FIRECRETE**

The most generally applicable type of Firecrete. Finely ground, permitting casting of shapes or linings as thin as 1½".

***For use up to*** **2400F — L-W FIRECRETE**

A lightweight insulating refractory concrete with unusually low thermal conductivity, low heat storage capacity and high resistance to spalling.

The above Firecrete materials can be used in combination where varying temperature and service conditions are encountered.

For patching and gunning, use 3X BLAZECRETE. For temperatures to 3000F. It has exceptional adherence qualities, can be flipped into place with a trowel without ramming or tamping.

For further information, write to Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

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**Johns-Manville**

**FIRECRETE**

"The Standard in Castables"

# News Digest

velopments in injection molding presses.

In anticipation of the coming trend for larger plastics parts made from thermo-plastics materials, General Electric has installed a pre-plasticizing injection press manufactured by the Jackson and Church Co., of Saginaw, Mich., at the G-E molding plant in Decatur, Ill.

Designed to produce plastics articles weighing up to 13 lb, the press can be easily converted to produce much larger items. It is now in production on large refrigerator components.

Weighing 135 tons and standing 27 ft in height, the 208-oz press incorporated a new patented mechanism that gives accurate control of pressure being applied in the mold. This feature permits close control of product quality, flexibility in product design, and broadens the potentialities for large plastics moldings. Pre-plasticizing equipment on the press enables the coloring and molding of certain types of plastics in one operation. Capacity, with polystyrene, is rated at 1,000 lb per hr on a continuous basis.

The production of large thermo-plastic moldings is now in the experimental stage, and the availability of plastics compounds will dictate to a considerable degree the speed in which the larger plastics items are put into production. It is entirely conceivable that entire lighting units, air-conditioning housings, plumbing fixtures, and numerous other large items for both homes and industry will be coming off production lines in the not too distant future.

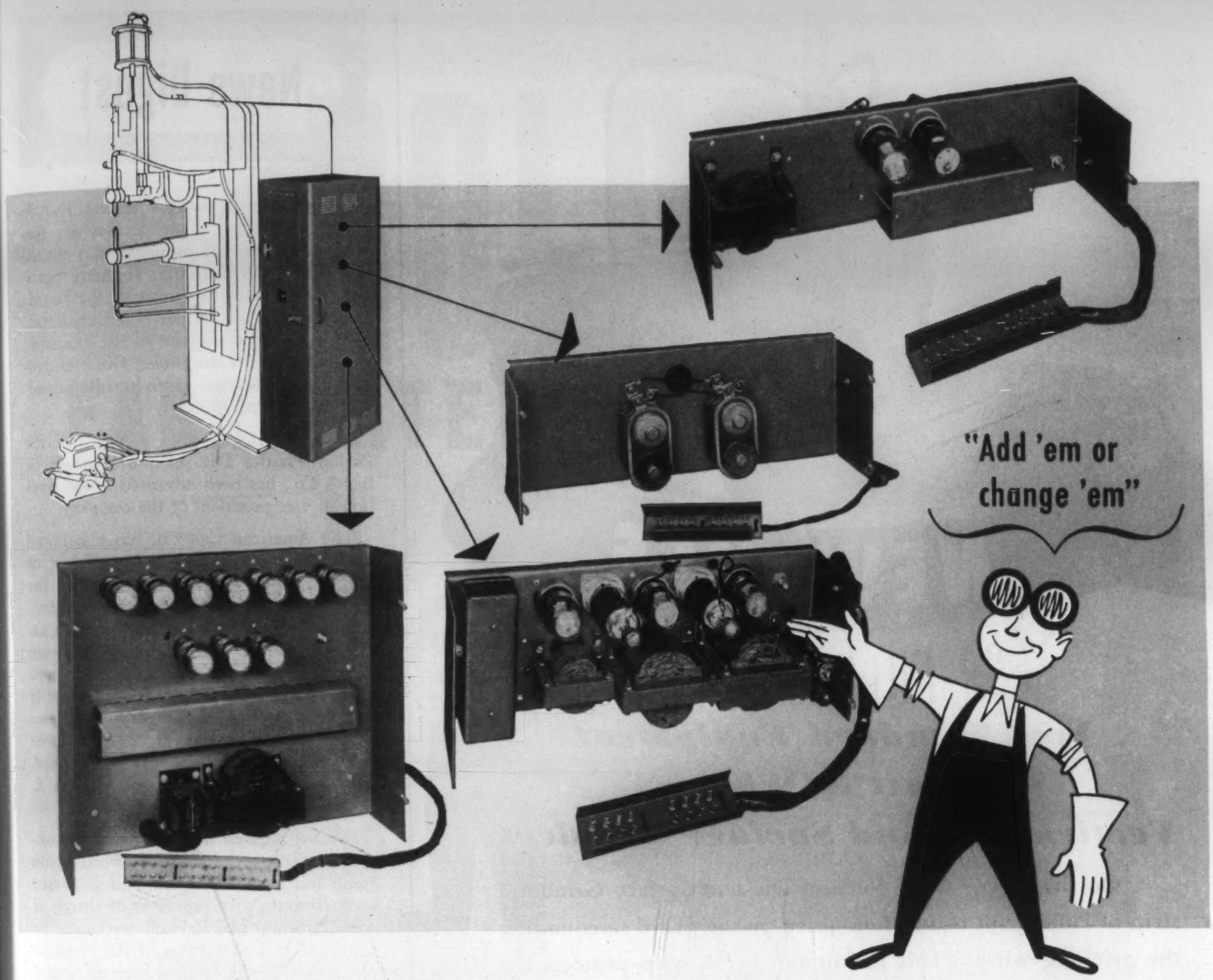
# News of Engineers

Dr. *Charles Allen Thomas,* one of the nation's leading atomic scientists, has been elected president of Monsanto Chemical Co. Dr. Thomas replaces *William M. Rand,* who is planning to retire.

The Chain Belt Co. has announced the election of *L. B. McKnight* to the newly created position of executive vice president.

*W. P. Nolan* has been appointed chief engineer of the Firth Sterling Steel & Carbide Corp. and *E. T. Barnes* has been named production manager.

Babcock & Wilcox Tube Co. has an-




# LET YOUR CONTROL LIVE A FULL LIFE

## Interchange components to keep it abreast of production changes

Why buy a resistance welding control today and "put it out to pasture" tomorrow because of obsolescence due to production changes?

Westinghouse Welding Controls keep pace with such changes. When a new welding technique is required, synchronous or nonsynchronous, seam or spot—interchange components to meet the need.

A Westinghouse Welding Control consists of a packaged combination of units to handle the initial technique. Each unit is self-contained and pre-wired at the factory. A polarized plug ties each unit into the basic circuit. Thus, it is a simple matter to replace these components or add new ones.

A complete line of component units meets most every welding technique you will use. Spot welding, seam welding, synchronous, nonsynchronous, slope control, heat control, weld treatment . . . there's a component to handle a wide range of each function.

Your Westinghouse representative will show you in detail how you can increase the life-span of your resistance welding control. Ask him for a copy of Booklet B-4309 or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-27007

YOU CAN BE SURE.. IF IT'S
Westinghouse

RESISTANCE WELDING CONTROL

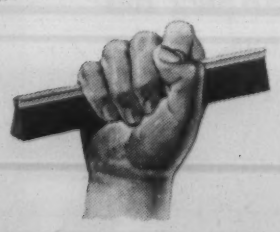
# NEW USE
## FOR FULLERGRIPT BRUSHES
### *Now Standard Equipment on Pratt & Whitney Vertical Die and Surface Grinders*

On the new P & W Vertical Die and Surface Grinder a strip of Fullergript brush is mounted on the guard surrounding the grinding wheel. This continuous brush strip protects the operator from spray, and at the same time cleans the work of grinding grit, thereby eliminating scratches and improving finish. Here you find Fullergript brush strip as a component part of a Pratt & Whitney machine that produces ultra-smooth, accurate surface finishes — in a minimum of time. Fullergript was selected because the brush material — in this case abrasion-resisting nylon — is densely packed, and anchored, in a continuous, rust-resistant metal channel. This Fullergript strip can be formed into innumerable shapes and attached to stationary or power-driven mountings. If you have not discovered the cost-cutting or product-improving possibilities of Fullergript, why not send for our booklet, "Fullergript Power Brushes". Write to . . .

FULLER BRUSH

FULLERGRIPT

*At home... in business, too*



THE FULLER BRUSH CO.
INDUSTRIAL DIVISION
3636 MAIN STREET • HARTFORD 2, CONNECTICUT


# News Digest

nounced several changes among its top executive officers: *Luke E. Sawyer,* formerly executive vice president, was elected president; *Alfred Iddles,* formerly president, was named chairman of the board; *Isaac Harter,* the former board chairman, was appointed consultant to the company; and *Edward A. Livingstone,* vice president assigned to sales, was given broader organizational responsibilities.

*John H. Moore,* sales manager of the Prolon Plastics Div. of the Prophylactic Brush Co., has been advanced to the position of vice president of the company.

The American Can Co. has announced the election of *C. H. Black,* president of the firm since 1949, as chairman of the board of directors, and *W. C. Stoke,* executive vice president, to fill the position vacated by Mr. Black. The new chairman succeeds *D. W. Figgis,* who will continue to serve the firm in an advisory capacity and as a director. *S. D. Arms* has been elected vice president in charge of the firm's Atlantic Div. Currently general manager of manufacture, he succeeds *R. L. Sullivan,* who has retired.

*Edward Barwell* has been named industrial relations coordinator of Worthington Pump and Machinery Corp. and will assist *L. C. Ricketts,* vice president in charge of manufacturing. Mr. Barwell served on the Industry Tri-Partite Panel of the National War Labor Board, and has been associated with Crocker-Wheeler Electric Manufacturing Co. since 1926.

At the recent board meeting, *Stanley F. Krzeszewski* was elected vice president of American Wheelabrator and Equipment Corp. He has served in the capacity of factory manager for the past 5½ years and will continue doing so.

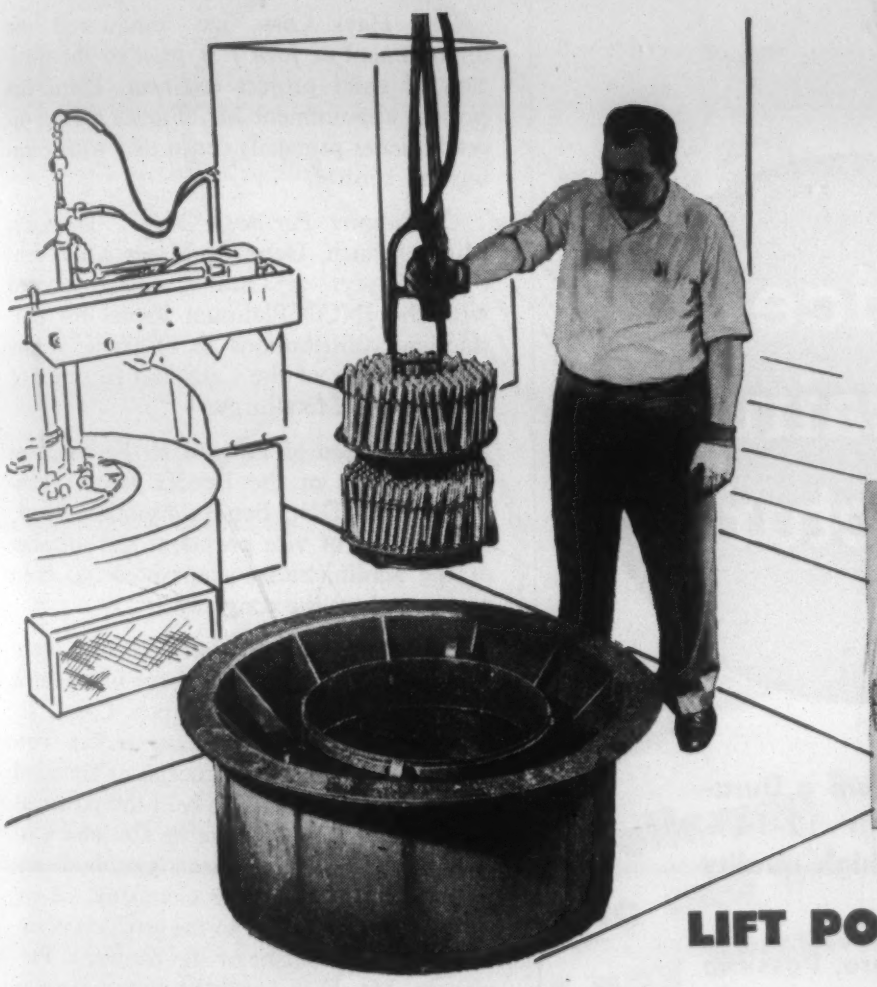
*John M. Olin,* president of Olin Industries, Inc., was elected chairman of the board of directors of the Ecusta Paper Corp., a subsidiary of Olin Industries.

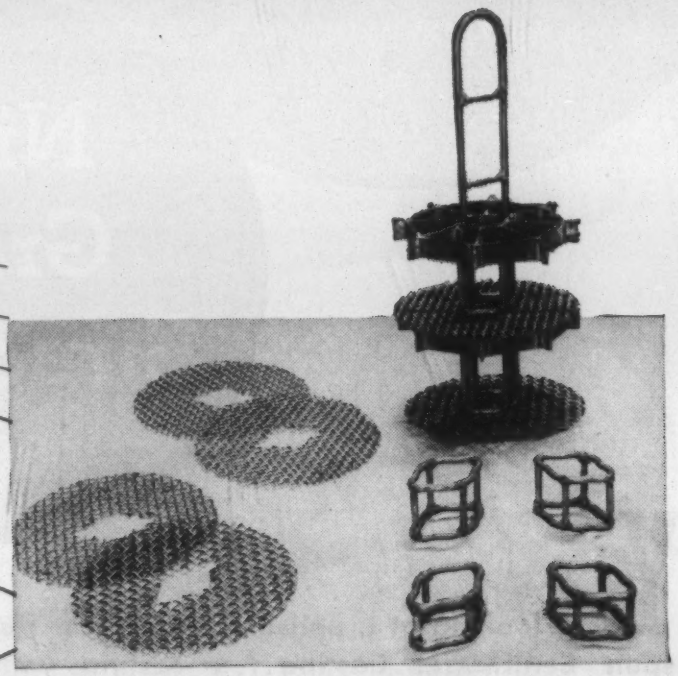
The New Britain Machine Co. has announced important changes and promotions within its organization. *Herbert H. Pace* will retire as president and will continue as chairman of the board. His successor, *Ralph T. Frisbie,* was advanced from a position as first vice president. *Ralph S. Howe,* who had been vice president, was elected executive vice president; *Julian C. Pease,* secretary, was elected a vice president and director of the company; *William J. Lafgren,* treasurer, was named secretary and treasurer. The following directors were also elected: *Leon P. Bradhurst, Robert S. Brown, Robert T. Frisbie, Ralph S. Howe, Donald H. Montgomery, Herbert H. Pease, Maurice H. Pease, Maurice Stanley, Philip B. Stanley, Frank G. Viberts* and *Julian G. Pease.*

*D. K. McIlvaine* has been appointed to the staff of the Powdered Metal Products Corp. of America as manager of the Elec-

# ROLOCK

## FABRICATED HEAT AND CORROSION RESISTANT ALLOYS





## LIFT POST CARBURIZING ASSEMBLY

### *of Extreme Versatility*

The Carburizing Assembly shown above was fabricated from Inconel by Rolock for Union Special Machine Co., Chicago . . . whose Industrial Sewing Machines are used throughout the world.

It consists of a lift post and bottom grid, to which may be added, at desired levels, a series of spacers, supporting grids and wire cloth screens of varied mesh sizes thru which steel shafts are vertically inserted for heat treatment, followed by direct oil quench in a flush tank, capacity 800 gallons continuous flow per minute.

Photo shows load of 200 lbs. in 54 lb. fixture (ratio almost 4 to 1) carburized at 1650° F. (.030 Case). The completely open structure permits uniform quench, no shielding, minimum warping (straight within .010"). Rolock designs, fabricates and welds all types of heat treating and finishing equipment for your specific needs . . . for better work, longer service life, lowest hour costs. Send us your problems . . . we'll give you sound solutions.

*Offices in:* PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • INDIANAPOLIS • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS

**ROLOCK INC. • 1282 KINGS HIGHWAY, FAIRFIELD, CONN.**

**JOB-ENGINEERED for better work**
**Easier Operation, Lower Cost**

4RL51

You're looking at a polished section cut from a Duraspun Centrifugal Casting...a casting with 12-14% chromium. It tells better than words of the high quality of Duraspun Centrifugal Castings.

You get a fine, dense, uniform grain structure. Possible air pockets and blow holes are eliminated. Tensile strength is higher than with static castings.

Order Duraspun if you need pipe or tubing. Sizes run up to 15 feet in length; up to 32 inches OD; and down to ¼ inch wall thickness. Odd shaped pieces can be produced providing a circular hole passes uniformly down the center. These, of course, require specially designed casting forms.

If, before ordering or asking us to quote, you would like to know more about our work and facilities, send for our Catalog 3150.

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# News Digest

tronics Div. Mr. McIlvaine was formerly associated with the Bell Telephone Laboratories and Western Electric.

At a recent directors meeting of The Youngstown Sheet and Tube Co., *J. Cameron Argetsinger,* due to ill health, tendered his resignation as vice president, an office he has held for 15 years. He will continue, however, in a consulting capacity. *E. Kirk Harris,* superintendent of the S. Chicago Coke plant for Youngstown has also retired after 35 years of service.

The Hays Corp. has announced the appointment of *Jack J. Tipton* to the position of chief project engineer. Until his present appointment Mr. Tipton was project engineer primarily concerned with combustion control.

*C. Stewart Parsons,* O.B.E., Director, Mines Branch, Dept. of Mines and Technical Surveys, at Ottawa, was presented with the INCO Platinum Medal for outstanding contributions to research, at the annual dinner of the Canadian Institute of Mining and Metallurgy.

The election of *Edward K. Foster,* general manager of the Bendix Radio Communications Div., Bendix Aviation Corp., to the posts of vice president and member of the administrative committee has been announced by the company.

Dr. *George O. Curme, Jr.* has been elected vice president in charge of research of Union Carbide and Carbon Corp., according to a recent company report. Formerly vice president in charge of chemical research, Dr. Curme also held the positions of vice president of Bakelite Co. and Carbide and Carbon Chemicals Co., both important divisions of the Company. *Morse G. Dial* was advanced to the position of executive vice president of the company. Previously, Mr. Dial has held such offices as secretary and treasurer, director, vice president and treasurer.

*Russell H. Dunham,* first president and chairman of the board of Hercules Powder Co., was recently honored for his leadership in the creation of the Company's research laboratories at a luncheon which marked the 20th anniversary of the opening of the Hercules Experiment Station. Various awards and mementos were presented to Mr. Dunham, who currently serves as a director of the Company and as chairman of the finance committee.

Various appointments, promotions and changes within its organization have been announced by Westinghouse Electric Corp. *E. W. Ritter,* manager of the Company's new Electronic Tube Div., has been named a vice president, and *E. V. Higgins* has been elected to the office of executive vice president of Westinghouse Electric International Co. Retiring is *William G. Marshall,* who has been vice president in charge of industrial relations for the past 17 years. Organizational changes in the

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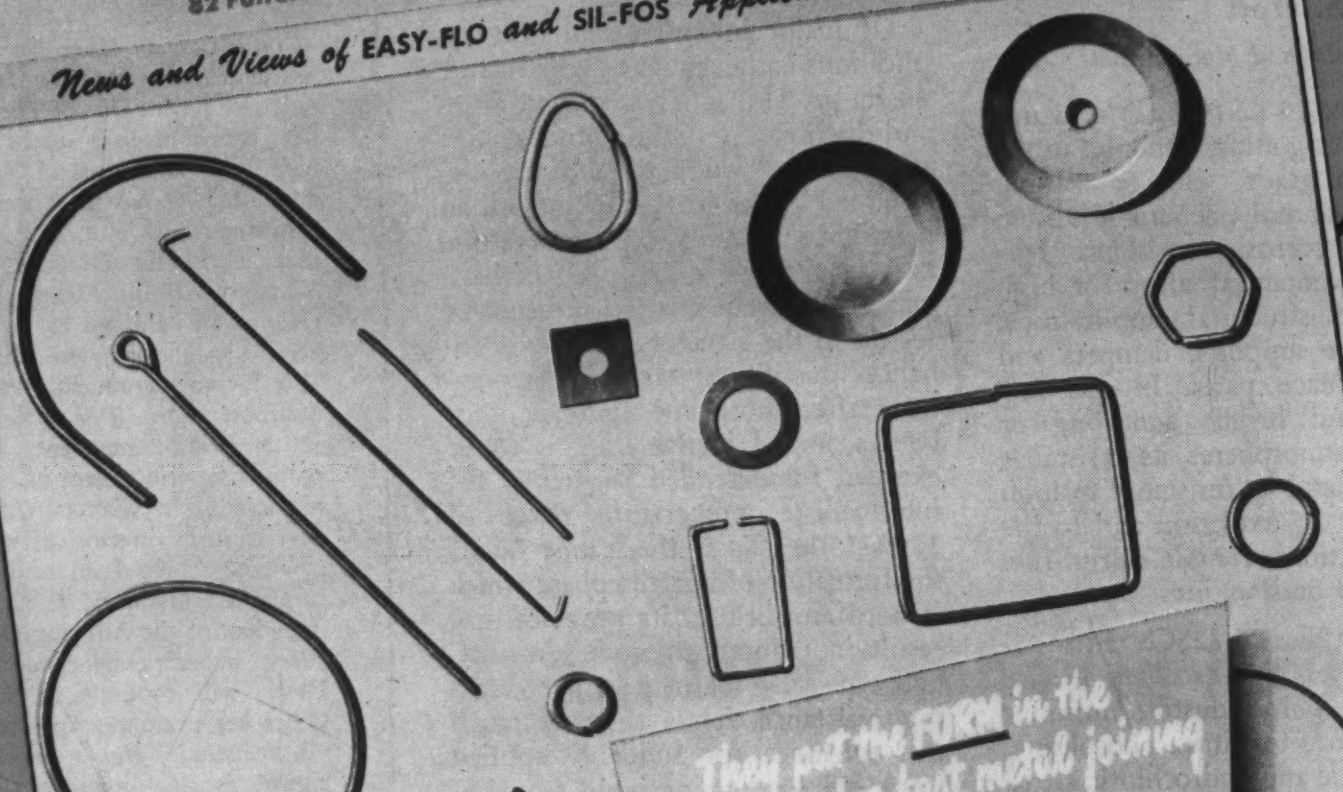


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# Technical Topics

## ALLOY TYPE 25-12

***Norman S. Mott***

***Chief Chemist and Metallurgist***

Alloy type 25-12 (CA22) is mainly a heat resisting alloy, although in the low carbon grade, with or without columbium or molybdenum, it is often used for its corrosion resistance. It is the most economical alloy for high temperature structural applications, such as tube supports, dampers and general furnace parts. In gas carburizing and bright annealing or hardening atmospheres its resistance is excellent and its resistance to high temperature air oxidation and to the corrosive action of high sulfur fuel flue gases is outstanding.

The 25-12S, 25-12SCb and 25-12SMo grades give excellent service in the sulfite pulp industry; and offer high resistance to nitric, phosphoric, dilute sulfuric and hydrochloric acids, as well as to organic acids such as citric, tartaric and lactic. 25-12S has better corrosion resistance than 19-9S, with carbon not being so critical. This holds for use in dilute sulfuric and hydrochloric acids at all temperatures, and in nitric acid at all concentrations and temperatures. In fact, in the boiling 65% nitric acid test 25-12S as cast is as good as 19-9S in the water quenched condition. The addition of molybdenum makes this alloy remarkably resistant, and its superiority in hot dilute sulfuric and hydrochloric acids over 19-9SMo is considerable. This suggests its use over 19-9SMo in some of the more exacting applications not necessitating the use of expensive FA-20 type alloy.

A.S.T.M. Specification B190-45T classifies the 25-12 alloy into two categories according to magnetic permeability: Type I, having a range of 1.05–1.7, and Type II, having a maximum of 1.05, after holding for 24 hours at 2000° F and water quenching. Since strength and ductility vary inversely at high temperatures, Type I containing ductile ferrite is able to resist fracture due to sudden overloads by yielding slightly under these stresses, but it has relatively low creep strength. Type II is completely austenitic and has high creep strength under conditions of constant loading, but is not as resistant to sudden shock.

Of major importance in heat applications is the influence of structure on its properties. The amount, form and distribution of the carbides affect strength and ductility and are determined by the percentage of carbon present in the alloy, the temperature, and the time of holding. Of perhaps greater importance is the presence of ferrite in the structure. While it enhances ductility at elevated temperatures after short-time aging, it must be discounted if the alloy is to be exposed for extended periods at the intermediate temperature range of 1200–1700° F, as this range favors the formation of a sigma phase which is hard and brittle. Its presence may result in reduced strength, ductility, and especially thermal fatigue cracking resistance. Thus there is much less tolerance for suddenly applied stress overloading or rapid temperature changes. Continued service about 1700° F. precludes this sigma formation.

To estimate ferrite on the basis of chemical analysis the Alloy Casting Institute suggests the following formula:

$$\text{R.F.} = \frac{[\%\ \text{Cr} + 3\ (\%\ \text{Si} - 1)] - [\%\ \text{C} \times 16]}{\%\ \text{Ni}}$$

A ratio factor less than 1.7 denotes a negligible amount of ferrite or sigma and corresponds to the A.S.T.M. limit in permeability value of 1.05. A ratio factor of 1.7–1.85 denotes 2–7%, and a ratio factor above 1.85 denotes above 7% of ferrite or sigma.

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COOPER ALLOY
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## News Digest

Small Motor Div. are: *H. E. Grout* was named works manager; *W. P. Bell* was promoted to manager of manufacturing for the Lima plant; and *C. F. Herbold* was advanced to the position of superintendent of quality control.

*John C. Van Horn* has been appointed assistant manager of the Technical Service & Development Div. of The Dow Chemical Co., according to a recent company statement. Announcement of its Madison Div. appointments has also been made by the company. *R. D. McNulty* has been named manager of the Division, while *D. W. Watters* will fill Mr. McNulty's former position in Midland as production manager for magnesium wrought products, and also become production manager at the Madison plant. *R. L. Dietrich,* formerly assistant superintendent, has been appointed superintendent of the rolling mill, to succeed Mr. Watters. *G. Ansel,* process development director of the magnesium laboratories, has been named chief metallurgist for Madison; *J. K. Haney,* superintendent of the Alloying Dept., and *R. E. Perry,* superintendent of the Extrusion Dept., will continue in these capacities. Other key personnel appointed to the Division include: *Henry Burke,* machine designer, as chief engineer; *W. H. Jones,* assistant to the production manager, as supervisor of administrative and service departments; *E. E. Van Stee,* assistant purchasing agent in Midland, as purchasing agent; *H. H. Lyon,* Midland Accounting Dept., as resident accountant; and *F. C. Mansfield,* formerly of the Emerson Electric Co., as personnel manager.

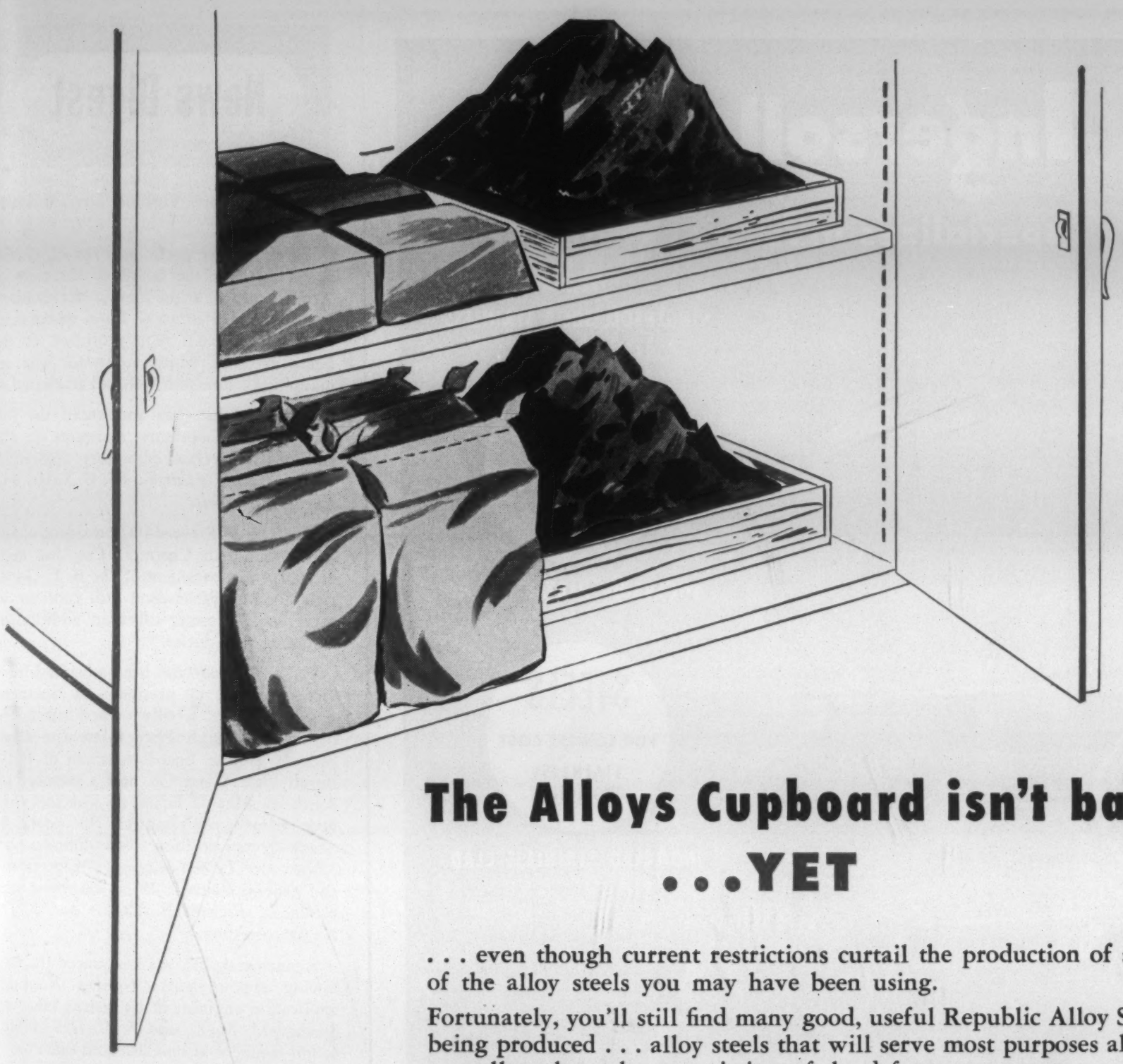
Election of *Orson A. Rockwell* as a vice president of the Calumet and Hecla Consolidated Copper Co., was recently announced by the company president. Mr. Rockwell is general manager of the Calumet Div.

*Roy A. Hunt,* president of the Aluminum Co. of America, was named chairman of the executive committee, and *I. W. Wilson,* senior vice president, was elected president of the Company at a recent ALCOA board meeting. *Arthur V. Davis* continues as chairman of the board, and *Leon E. Hickman* was elected vice president and general counsel for the company.

At a recent meeting of the board of directors, *John P. Kelsey* was elected an assistant treasurer of Sharon Steel Corp.

*F. A. Ludington, Jr.* was named assistant vice president of the Chase Bag Co. Mr. Ludington was serving in a managerial capacity at the company's Philadelphia branch when appointed to his new office.

*W. E. Blowey* has been appointed divisions engineer of General Electric's Steam Turbine, Generator and Gear Engineering Divs. at Lynn, Mass., and *L. B. Wales* has been named division engineer of the Com-



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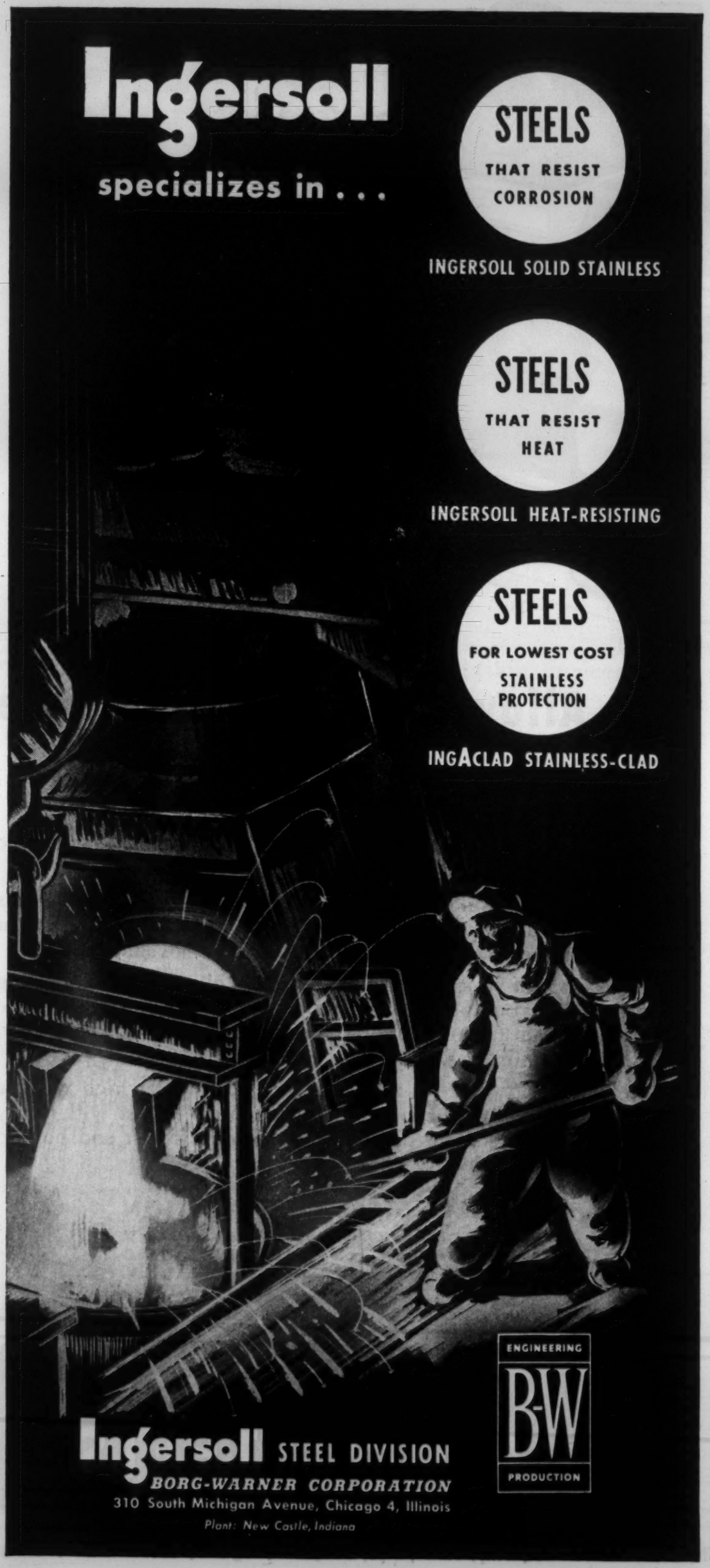



# News Digest

pany's Auxiliary Turbine Div. at Fitchburg, Mass.

Executive vice president *Fred M. Gillies* was elected to the board of directors of Acme Steel Co. at the annual stockholders' meeting, and *William C. Fork*, works manager, was elected vice president at the board meeting which followed. The remaining 12 directors were all re-elected.

Horizons, Inc. has announced the following new laboratory assistants to the staff of its Cleveland laboratory: *Robert M. Ulmer, Paul E. Pauliska, W. C. Snider* and *Lucille Campbell.*

*William S. Richardson,* president of the B. F. Goodrich Chemical Co., has been elected a vice president of the B. F. Goodrich Co. Mr. Richardson will continue to serve in his former office in addition to assuming new duties.

*E. T. Asplundh* has been advanced from vice president to president of Southern Alkali Corp., a wholly owned subsidiary of the Pittsburgh Plate Glass Co. *Clarence M. Brown,* board chairman of Pittsburgh Plate Glass Co. and a member of Southern Alkali's board of directors, has been named chairman of the board, a newly created position. New directors and officers are: *Leland Hazard,* vice president and general counsel; *W. I. Galliher,* vice president; *Richard B. Tucker* and *E. D. Griffin,* directors.

Kennametal, Inc. has announced the following appointments: *Gordon Kimball,* application engineer at its district office in Springfield, Mass., and *F. O. Hill,* application engineer at its Cleveland office.

The Industrial Chemicals Div. of American Cyanamid Co. has announced that *W. D. Thomas, Jr.,* has been appointed technical representative of the Petroleum Chemicals Dept. *J. B. Peeso, Jr.* will assume Mr. Thomas's former duties as group leader of the Petroleum Chemicals Laboratory, Technical Service & Development Div.

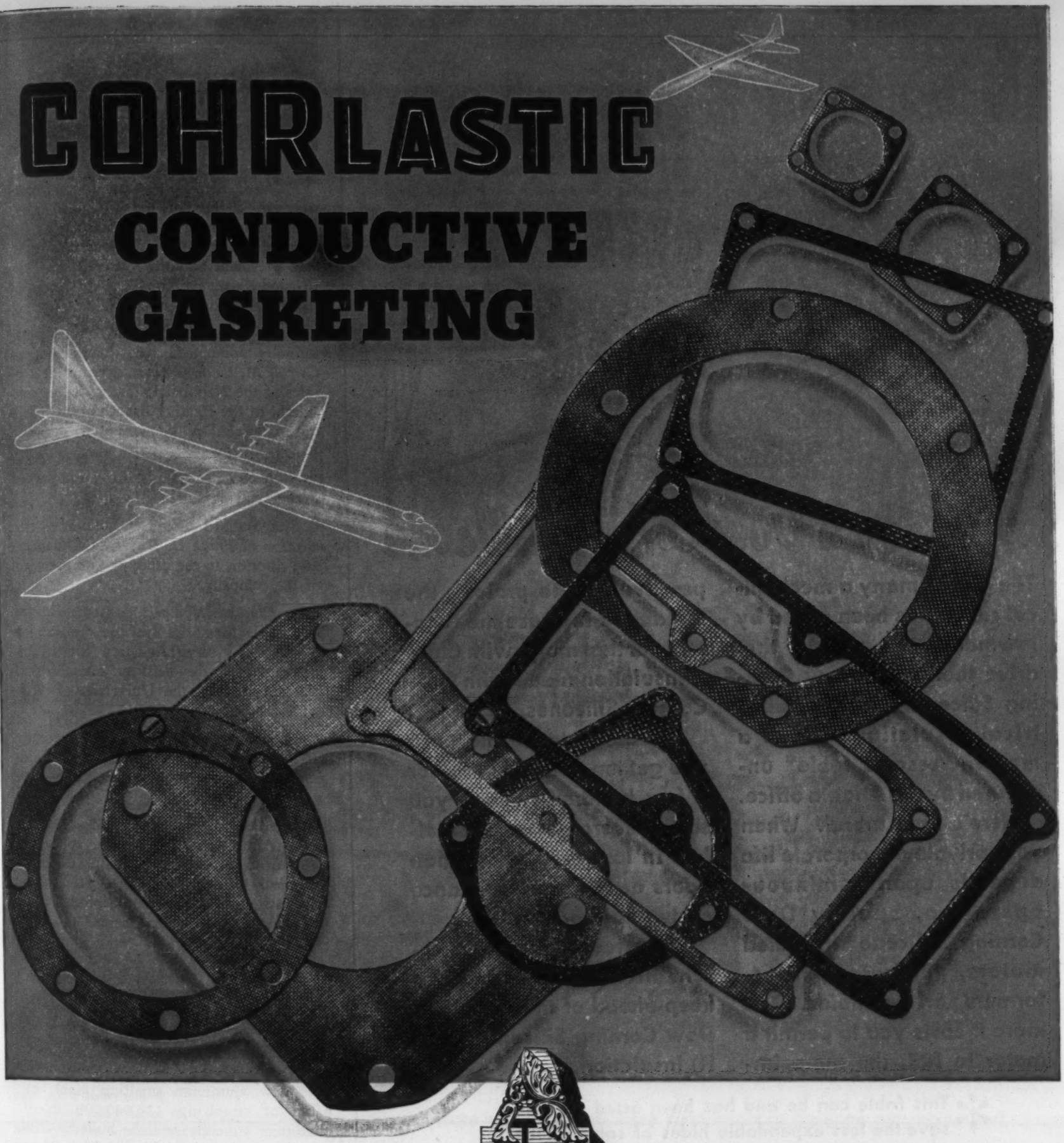
*Edward F. Krieger,* formerly company production manager, has been named vice president in charge of manufacturing for the Bolta Co. and Bolta Products, Inc.

The Scaife Co. has announced the appointment of *Allison L. Bayles* as vice president of engineering and *Allen M. Harrelson* as controller. Mr. Bayles was formerly associated with C. H. Wheeler Manufacturing Co. and American Engineering Co.

*K. Theodore Korn,* industrial engineer, has recently been appointed as a senior associate by Edward A. Berk & Associates.

*Bruce A. Dean,* formerly general sales manager of The Mengel Co., Inc., has been elected vice president in charge of sales of Chase Brass & Copper Co. He will succeed *Sherman H. Perry,* who plans to retire.

# COHRLASTIC
## CONDUCTIVE GASKETING



special gasketing that both seals and conducts high frequency currents. It makes an air-tight seal and yet prevents leakage of high frequencies between the bolt holes.

Cohrlastic conductive gasketing provides a continuous mounting and minimizes high frequency losses that affect radio operation.

It is widely used in aircraft (1) between the magnetos and their bases, (2) in the ignition harness, (3) in quick disconnect plugs and (4) wherever shielding is required.

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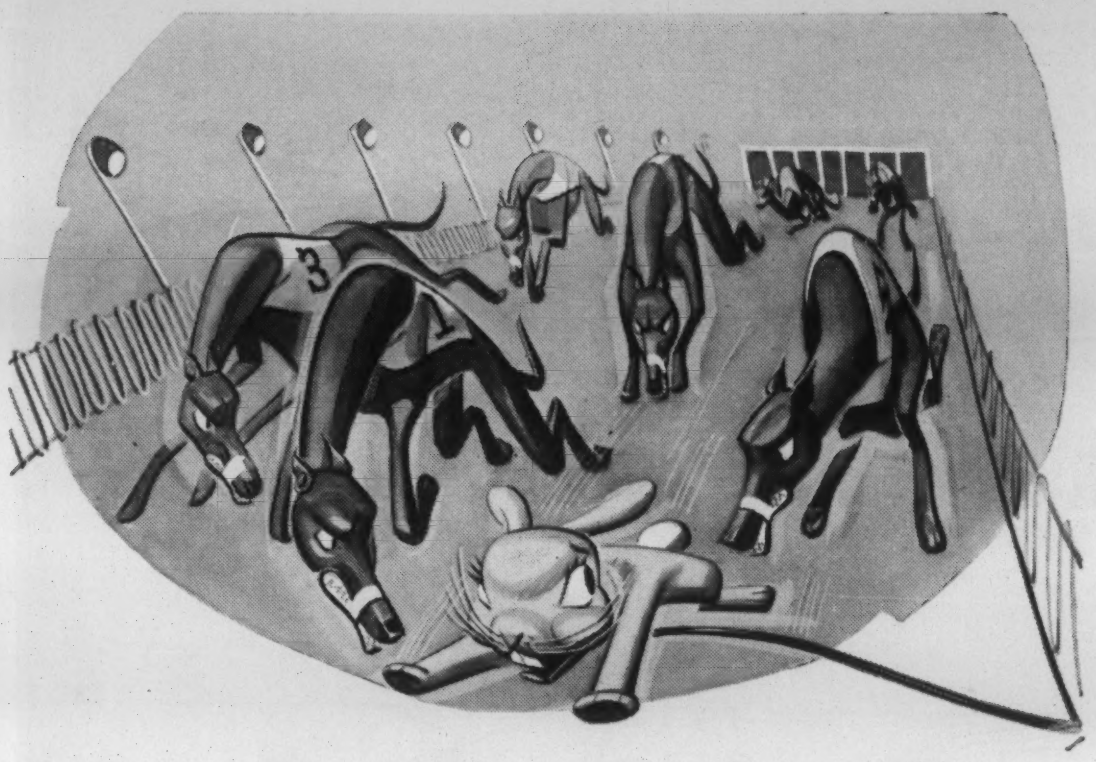

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## News Digest

*Ralph E. Knight,* assistant general manager in charge of the Chemical Div., Kaiser Aluminum & Chemical Corp., has been advanced to two additional positions: vice president of both Kaiser Magnesium Co. and Kaiser Bauxite Co., subsidiaries of the Corporation.

The National Production Authority has formally announced the appointment of *Carroll M. Baumgardner,* vice president of sales of the National Radiator Co., as consultant to the Heating Branch of its Building Materials Div.

*Stella R. Ellis* has been advanced to the position of chief chemist for Hunt-Spiller Manufacturing Corp.

The Bullard Co. has announced the election of *Frank U. Hayes,* sales manager and director, to the office of vice president of the company.

Dr. *Clarence H. Loriz,* assistant director of Battelle Memorial Institute, received a distinguished service citation for accomplishments in the field of metallurgical engineering from the University of Wisconsin.

*Ralph Henderson Everett* was recently elected a director of Automatic Steel Products, Inc. He will serve in this capacity for a term of three years.

Brigadier-General *Edward Montgomery,* U. S. Army, retired, has been appointed assistant to the executive vice president of Chemical Construction Corp. His duties will include the coordination of the work of several company departments.

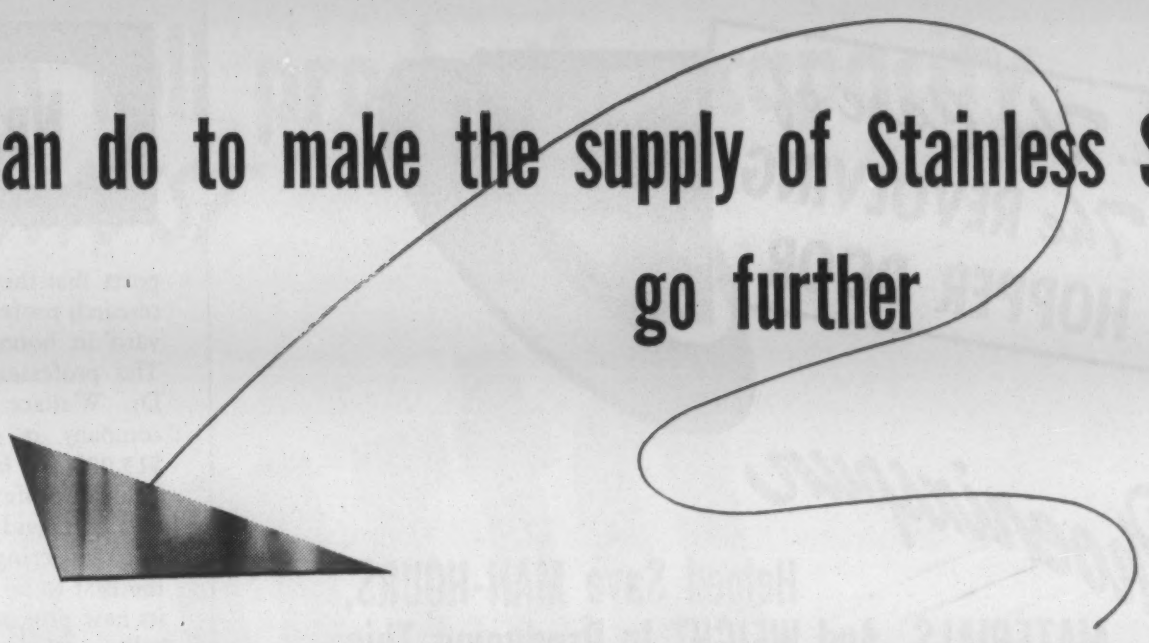
## News of Companies

A new aluminum smelting plant, capable of supplying 170,000,000 lb of aluminum annually, will be built by *Aluminum Co. of America* at Wenatchee, Wash. Immediate construction of the new works is planned, and it is expected that operations will begin within 15 months.

*Norton Co.* has announced the formation of the Norton Distributor's Advisory Council, made up of representatives of 11 Norton abrasive distributors from Conn. to Calif. Organized in an attempt to obtain the benefit of the experience of representative distributor men, the council is believed to be the first of its kind in the abrasive industry.

A new $30,000,000 experimental station of *E. I. du Pont de Nemours & Co., Inc.* was recently dedicated before an assembly of 200 distinguished academic and industrial scientists. The station, located near the site of the Company's original plant, will house nearly half of du Pont's total research personnel. The Company also re-

What you can do to make the supply of Stainless Steel go further



# Make full use of the steel you get by keeping down scrap losses in your shop

**Keep these points in mind, too, when you order Stainless**

Tell your supplier exactly where you'll use Stainless and how you'll fabricate it.

Minimize scrap losses at the mill by ordering the exact sizes that you will use.

Indicate, if possible, acceptable alternates in composition, gage and finish.

Holding your own scrap losses to a minimum to make the fullest use of the steel you receive is good shop practice anytime. It's especially important today.

Here are a few suggestions that may help you stretch your supplies. See that they are followed. Add other rules that your operations may dictate.

1. **Lay out your jobs to use steel as economically as possible. Then order to the closest possible size.**
2. **Keep your stock of Stainless Steel carefully separated by grades.**
3. **In your storage areas, make sure that surface finishes are protected properly.**
4. **Lay down strict rules for careful fabrication and handling. It will help you reduce rejections.**

No matter how carefully these rules are followed, there'll always be a certain amount of scrap. To keep new steel flowing to you, get your scrap back into circulation as quickly as possible by *promptly* turning in every pound to the mills.

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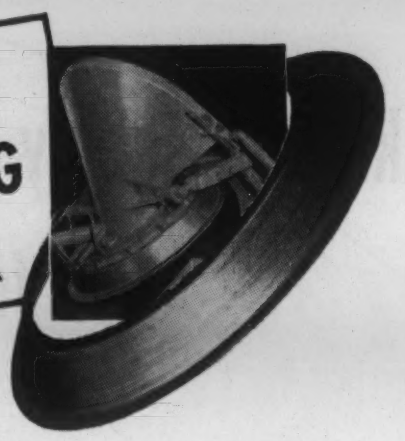
UNITED STATES STEEL

## ..The Case of The REVOLVING HOPPER DOOR



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**THE PROBLEM:**—How to reduce production time, materials, and weight while improving the quality and serviceability of the revolving hopper door for The T. L. Smith Company's "SMITHMOBILE" Truck Mixer.

**THE SOLUTION:**—Use of #10 U. S. Gauge steel spun by the "PHOENIXSPUN" method — without need for costly dies, reducing weight by replacing casting, and eliminating man-hours for machining due to smoothness and accuracy of finished doors.

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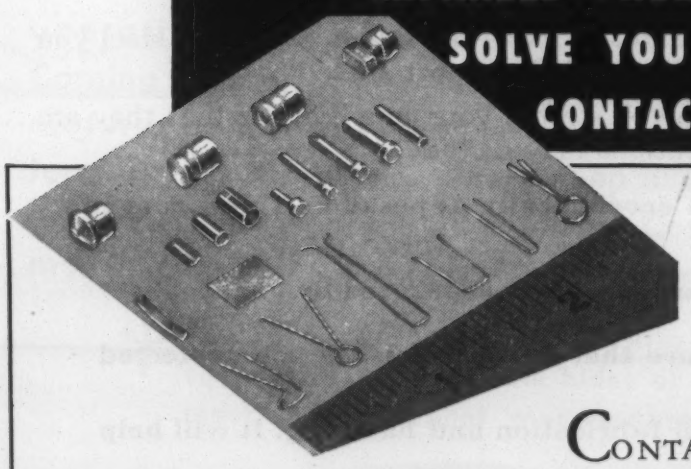

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# News Digest

ports that they have established an annual research professorship in chemistry at Harvard in honor of the inventor of nylon. The professorship is named for the late Dr. Wallace Hume Carothers, and the company is making an annual gift of $15,000 for five years to support the appointed professor and his research. Selection of David L. Arm, dean of the School of Engineering, University of Delaware, as the first to be brought into du Pont under its new program for providing engineering college educators with a year of practical experience, was also announced by the company.

The National Safety Council has granted its highest honor, The Distinguished Service to Safety Award, to *National Carbon Co.*, a division of Union Carbide and Carbon Corp. The award was given in recognition of the firm's record in reducing employee accident rates each year for four consecutive years.

In order to help meet the increased demand for protective finishes and industrial coatings, *United Lacquer Corp.*, has an explosion-proof factory building under construction that will provide 4000 sq. ft. to be devoted to manufacturing operations. The building is scheduled for completion next month.

The *Bryant Chucking Grinder Co., Fellows Gear Shaper Co.* and *Jones and Lamson Machine Co.*, all of Vermont, are planning to open a new joint office and showroom at 5835 W. North Ave., Chicago, about June 1.

Headquarters of *Rem-Cru Titanium, Inc.* have been established at Midland, Pa., where the company's production, sales and research activities are to be centered.

The *Nevada Scheelite Co.*, with mines and mill near Rawhide, Nev., is being transferred by sale of stock to *Kennametal, Inc.*

More than 750 business leaders, civic officials, customers and dealers recently attended the opening of *U. S. Rubber Co.'s* new branch office and warehouse at 900 S. Jefferson Davis Pky., New Orleans. The new office will be headquarters for the distribution of products for all Louisiana, as well as for parts of Alabama, Florida and Mississippi.

*Fiberglas Reinforced Plastics* Sales headquarters have been moved from Toledo, Ohio to New York. Company activities will now be located in a newly remodeled wing of the Fiberglas Building, 16 E. 56th St., under the direction of Ralph Perkins, Jr., plastics sales manager.

*Servomechanisms, Inc.* is relocating its main office and home plant to new and larger quarters at Post and Stewart Ave., Westbury, L. I., N. Y.

*Rust Engineering Co.*, Pittsburgh, has been engaged as engineer-constructor of the

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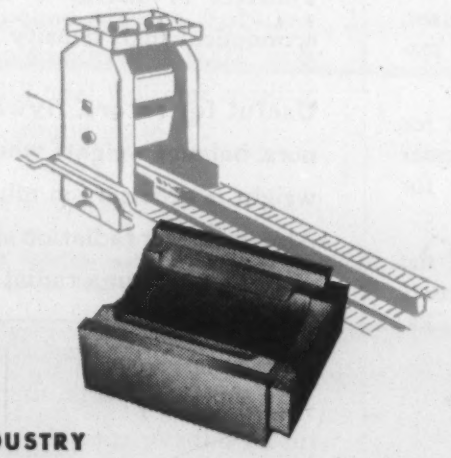

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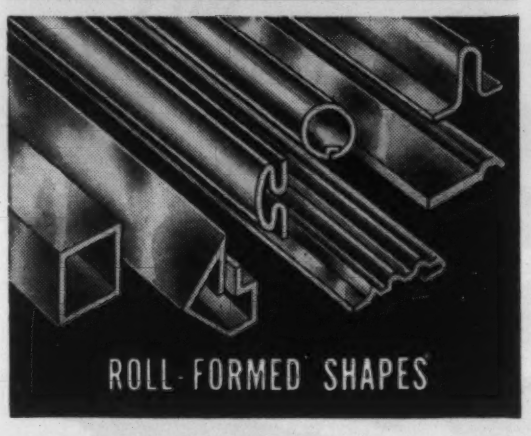


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# News Digest

new phosphate chemical plant being built near Mulberry, Fla. by the Phosphate Div., *International Minerals and Chemical Corp.* The $10,000,000 project will produce defluorinated phosphate and multiple superphosphate. Uranium products will be recovered as a by-product.

*Pennsylvania Optical Co.* announced it is introducing a complete line of industrial lenses under its own trade mark—Penoptic.

Construction of a new, $3,800,000 plant in Nassau County, L. I., N. Y., has been announced by *Lewyt Corp.* The new plant is expected to employ some 2000 persons, and will produce electronic devices for the armed forces.

*American Cyanamid Co.* has announced that construction will begin soon on a 64,000 sq ft building in Los Angeles which will be leased to them for a long period of time. The Company has also arranged to lease a 60,000 sq ft building, 1055 Commonwealth Ave., Boston, to house its operations there. The new facilities replace four separate offices and four warehouses formerly used by the firm in Boston.

In order to alleviate the critical shortage of Resorcin, which is hampering production of defense materials, the Chemical Div. of *The Bordon Co.* has applied to the NPA for authorization to construct a Resorcin manufacturing plant in Tacoma, Wash.

*Cleveland Vibrator Co.* has recently completed another addition to its plant, which will house new automatic screw machines.

Construction on additional facilities for the *B. F. Goodrich Co.'s* research center has been started and will be ready for occupancy in October, 1951.

*Laclede-Christy Co.* has announced the purchase of the plant and physical assets of *Paterson Fire Brick Co.*, Clearfield, Pa.

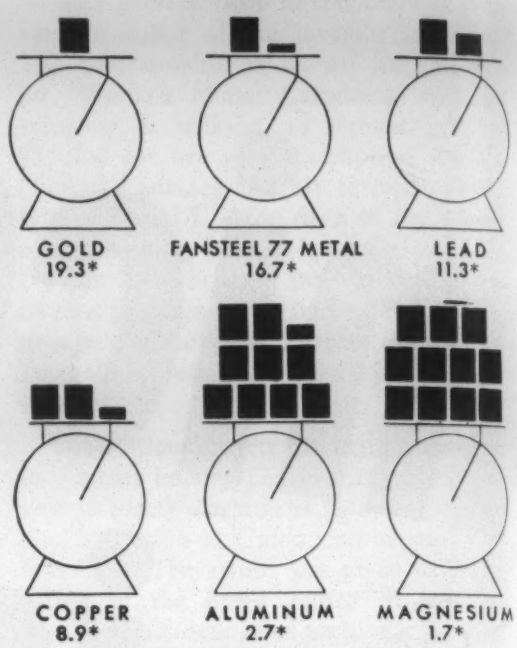
*Crucible Steel Co. of America* has announced a $27,250,000 program to expand its steelmaking capacity at its Midland Works.

Details of a $6,500,000 plant expansion program have been announced by *Minnesota Mining and Manufacturing Co.* Most of the projects, located in ten cities and eight states, are already underway.

# News of Societies

According to a recent announcement by Dr. Theodore P. Wright, acting president of *Cornell University*, the new $1,700,000 center for the study of engineering materials will bear the names of two Cornell


# For High Density In Small Space




*GRAMS PER CUBIC CENTIMETER

Fansteel
# 77 Metal

Strong and machinable, with a density almost as high as gold and closely approaching that of pure tungsten, Fansteel 77 Metal is the practical, economical high density material.

Useful for rotors, flywheels, governors, balance weights where maximum weight is necessary in minimum space. Also useful for radiation shields against X-ray and gamma radiation.

Available forms include finished or semi-finished parts, bar, rod, rings, disks, slabs or special shapes. Fansteel Metallurgical Corporation, North Chicago, Illinois, U. S. A.

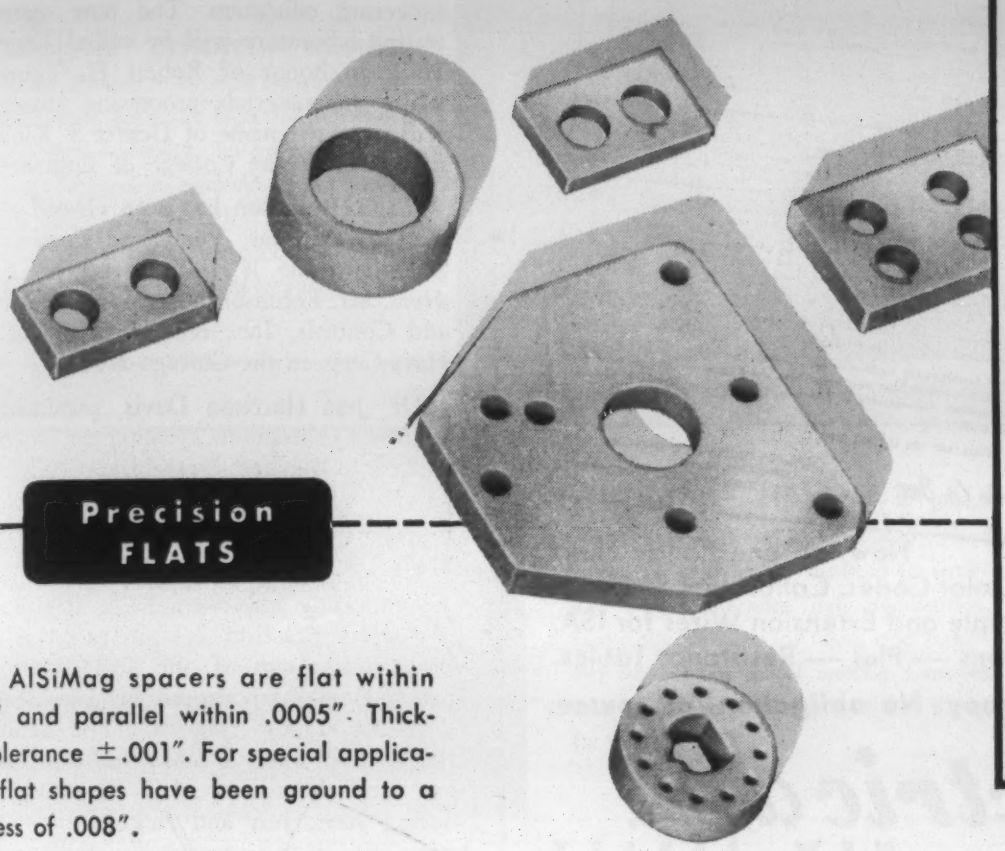
*Ask for Bulletins:*

☐ Fansteel 77 Metal
☐ Fansteel Siliconized Molybdenum
☐ Fansteel Tungsten and Molybdenum
☐ Fansteel Tantalum

12501-A

Fansteel
SPECIAL PRODUCTS
*In Controlled Metallurgy*

# It's a fact that



## Precision FLATS

These AlSiMag spacers are flat within .0002" and parallel within .0005". Thickness tolerance ±.001". For special applications, flat shapes have been ground to a thickness of .008".

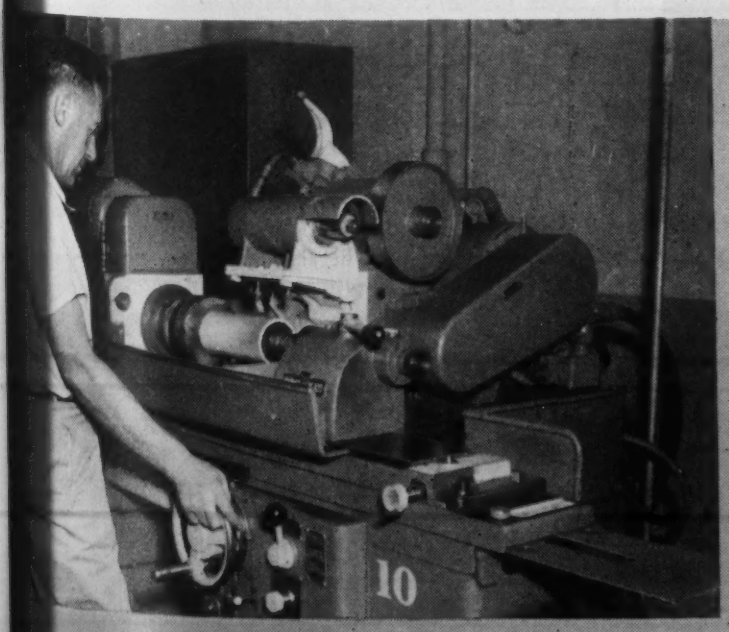
- We have advanced the technique of grinding AlSiMag ceramics so that we can obtain, on critical dimensions which lend themselves to grinding, the accuracy of comparable precision metal parts.
- Moreover, AlSiMag ceramics are more wear resistant than steel and, in many designs, can be manufactured to close tolerances at lower cost.
- Grinding is most practical on flat and round surfaces. We are equipped to grind flats up to 50 sq. in., rods up to 10" diameter and holes as small as 3/16"

**AlSiMag**
TRADE MARK REG U.S. PAT. OFF

## Precision ROUNDS

These centerless ground AlSiMag shafts are held to diameter tolerances of ±.0002" and straight within .010, total indicator reading (.005 Camber), in lengths up to 9".

advanced grinding and lapping methods now permit dimen- accuracy formerly considered impossible in technical ceramics.



• If you have a design problem which might be solved by an AlSiMag technical ceramic made to close tolerances, send us your blue print and an outline of your requirements. Our comments and recommendations will be furnished promptly.

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NEW ENGLAND, 38-B Brattle St., Cambridge, Mass Kirkland 7-4498 • ST LOUIS, 1123 Washington Ave., Garfield 4959

# AT YOUR FINGER TIPS

## COLOR CODES for Pyrometer Wires

CALIBRATION SYMBOLS AND COLOR CODES FOR THERMOCOUPLE AND EXTENSION WIRES

| APPLICATIONS | THERMO-ELEC. CO.'s CAL. SYMBOLS | ISA CAL. SYMBOLS | CONDUCTORS POLARITY POS. (+) | NEG. (−) | U. S. A. OVERALL | U. S. A. POS. (+) | U. S. A. NEG. (−) | T.E.Co.'s—AERO. APPLICATIONS OVERALL | T.E.Co.'s—AERO. APPLICATIONS POS. (+) | T.E.Co.'s—AERO. APPLICATIONS NEG. (−) | U. S. MILITARY SPECIFICATIONS OVERALL | U. S. MILITARY SPECIFICATIONS POS. (+) | U. S. MILITARY SPECIFICATIONS NEG. (−) | CALIBRATIONS USED FOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EXTENSIONS | B | VX | IRON | CONSTANTAN | BLACK | GREY | RED | TAN | BLACK | YELLOW | MIL-W-5845 See Note * | BLACK | YELLOW | |
| THERMOCOUPLES | BT | Y | IRON | CONSTANTAN | BROWN | GREY | RED | | | | | | | |
| EXTENSIONS | A | JX | IRON | CONSTANTAN | BLACK | WHITE | RED | BLACK | BLACK | YELLOW | | | | |
| THERMOCOUPLES | AT | J | IRON | CONSTANTAN | BROWN | WHITE | RED | | | | | | | |
| EXTENSIONS | C | WX | IRON | ALLOY | WHITE | GREEN | RED | WHITE | GREEN | RED | MIL-W-5846 See Note † | WHITE | GREEN | |
| EXTENSIONS | CL | KX | CHROMEL | ALUMEL | YELLOW | YELLOW | RED | | | | | | | |
| THERMOCOUPLES | CT | K | CHROMEL | ALUMEL | BROWN | YELLOW | RED | BLACK | BLACK | GREEN | | | | |
| EXTENSIONS | D | TX | COPPER | CONSTANTAN | BLUE | BLUE | RED | | | | | | | |
| THERMOCOUPLES | DT | T | COPPER | CONSTANTAN | BROWN | BLUE | RED | | | | | | | |
| EXTENSIONS | PR | SX | COPPER | ALLOY | GREEN | BLACK | RED | | | | | | | |
| THERMOCOUPLES | P | SP | PT 10% RH | PLATINUM | | | | | | | | | | |
| | | RP | PT 13% RH | PLATINUM | | | | | | | | | | |

* MIL-W-5845 or AN-W-8 Wires
Type II
Class A—LIGHT BLUE
Class B—LIGHT BLUE—1 RED TR.
Type III
Class A—LIGHT BLUE—2 BLACK TRS.
Class B—LIGHT BLUE—2 RED TRS.

† MIL-W-5846 Wires
Type II Class A—WHITE—1 GREEN TR.
Type III Class A—WHITE—2 GREEN TRS.
Type IV Class A—WHITE—3 GREEN TRS.
AN-W-29 Wires
Type I Class A or B—WHITE—1 GREEN TR.
Type II Class A or B—WHITE—2 GREEN TRS.
Type III Class A or B—WHITE—3 GREEN TRS.

NOTES: OVERALL INSULATION

The Color Codes of our Thermocouple and Extension Wires conform to the above tables. These wires, available in all standard calibrations, are insulated with low and high temperature plastics, braided or served asbestos, cotton or fiberglass. All fibrous insulations are saturated with suitable compounds for added resistance to moisture and abrasion. For severe abrasion, a protective high temperature metallic wire or ribbon can be braided directly over the outer insulation.

Complete manufacturing facilities at our plant for the fabrication, selection, calibration and testing of these wires assure high standards of accuracy and quality. For dependable Thermocouple or Extension Wires . . . . Choose a Thermo Electric Wire.

ELECTRICAL RESISTANCE TABLES OF PYROMETER WIRES ARE ON REVERSE SIDE.

THERMOCOUPLES FOR AIRCRAFT
ENGINES AND INDUSTRIAL PLANTS
PYROMETER INSTRUMENTS

QUICK COUPLING CONNECTORS
CONNECTOR PANELS
PROTECTION TUBES AND ACCESSORIES

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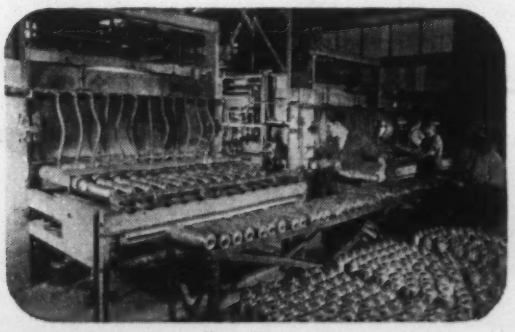
FAIR LAWN, NEW JERSEY

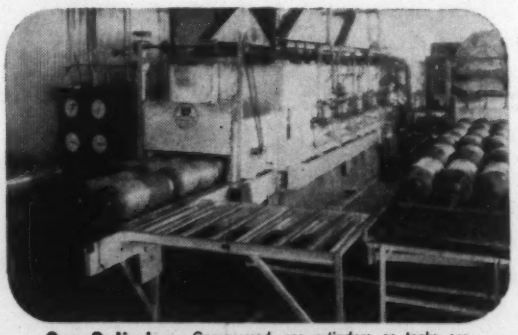
Now, on one handy chart
(8 ½ " x 5 ½ ") Color Codes, Calibration Symbols,
Thermo Elements of Thermocouple and Extension Wires for ISA,
U.S. Military and Aeronautical Specifications — Plus — Resistance Tables.

***Write Today for your copy. No obligation, of course.***

# Thermo Electric Co., Inc.
FAIR LAWN, NEW JERSEY



**Shell Forgings** 75 mm, 90 mm, 105 mm and other sizes are scale-free hardened, uniformly, automatically and continuously, in these and other EF gas fired installations.



**Gas Cylinders** Compressed gas cylinders or tanks are continuously normalized and annealed—scale-free, inside and out—in this and other EF gas fired furnaces.

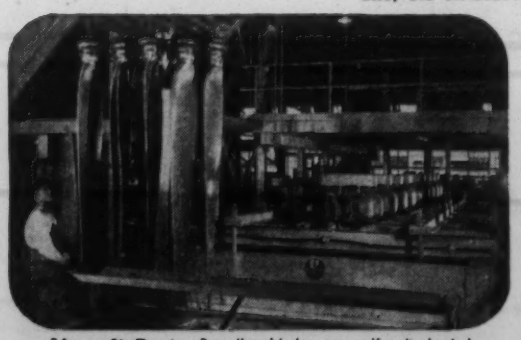
**Typical EF Furnace Installations for**

# Defense Production

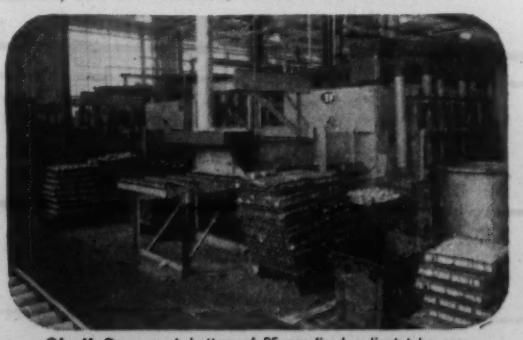
We have the drawings and have already built these and many other defense production furnaces. Years of experience and complete manufacturing facilities enable us to give dependable service on furnaces for treating jet or propeller type engine parts; tank, automotive or aircraft parts; armor plate; metal powder products, ammunition components and other defense products.

Ask for Bulletin 461-DP

**THE ELECTRIC FURNACE CO. • SALEM, OHIO**
GAS, OIL OR ELECTRIC FURNACES, FOR ANY PRODUCT, PROCESS OR PRODUCTION



**Aircraft Parts** Propeller blades are uniformly heated and quenched in this EF continuous furnace. Types available for other propeller and jet type engine and aircraft parts.



**Shell Cases** A battery of EF gas fired radiant tube continuous special atmosphere, clean annealing and stress relieving furnaces. Other types available for steel or brass.


# News Digest

faculty members who pioneered in engineering education. The new materials testing laboratory will be called Thurston Hall, in honor of Robert H. Thurston, while the materials processing laboratory will carry the name of Dexter S. Kimball, first dean of the College of Engineering.

T. G. Robinson has been elected chairman of the Gas, Fuels and Combustion Section of the *Western Society of Engineers*. Mr. Robinson is president of Meters and Controls, Inc., representatives of the Hays Corp. in the Chicago area.

Dr. Jess Harrison Davis, president of Clarkson College of Technology, has been elected to succeed Dr. Harvey Nathaniel Davis, who is retiring as president of *Stevens Institute of Technology* after 23 years.

Continuing improvement in steel foundry safety practices is anticipated as the direct outgrowth of the 1951 National Safety Contest sponsored by *Steel Founders' Society of America*. The national competition, open to more than 150 member steel foundries, will be conducted during June, July and August.

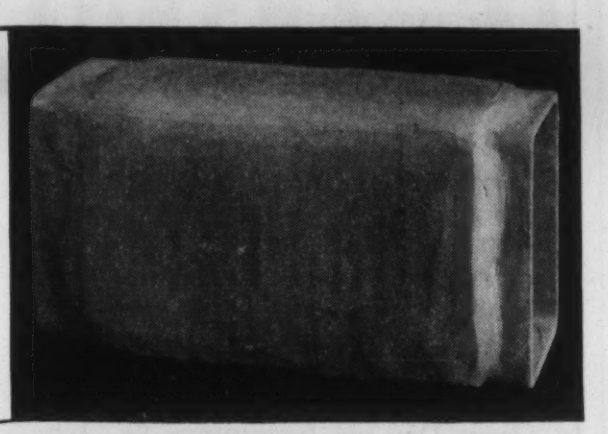
The first International Nickel Co. graduate fellowship in metallurgical engineering at the *Illinois Institute of Technology* has been awarded to Charles H. Parcells, instructor in metallurgy at the University. The fellowship, one of two established by INCO, provides for two years' study leading to a doctor's degree and carries an annual award of $1500 and tuition. Illinois Tech has also announced Frederick J. Clemens, Senior at the Aeronautical University, as the winner of first place for his paper on "The Development and Operation of the Helicopter" at the annual student-member meeting of the *Society of Automotive Engineers*, held on the school campus. Another announcement, naming Thomas P. Collier, assistant general manager of export operations for Inter-American Orange-Crush Co., as manager of international research operations at the Armour Research Foundation of the Illinois Institute of Technology, was also released.

The *Electrochemical Society*, during its national spring meeting, announced the establishment of The Palladium Medal, to be awarded biennially for original and outstanding contributions to the knowledge of corrosion and its control.

According to a recent announcement by the *American Foundrymen's Society*, a program to found a technical center for the production of cast metals vital to the nation's rearmament program is well underway. Over $95,000 of the $100,000 has been raised by voluntary subscription, and the center is to be established during the next two years in one of the principal midwestern foundry centers.

# Three Refractory Cements For Lower-Cost Heat-Control

**ALUNDUM* CEMENT** — Electrically fused alumina in its most dense and unshrinkable form. Its high refractoriness, electrical resistivity, thermal conductivity and resistance to oxidation make it ideal for embedding electrical resistors, ramming burner blocks, setting bricks and lining certain metal melting furnaces.

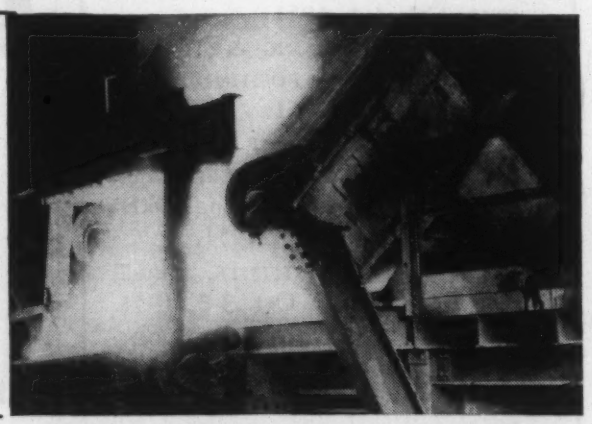


Resistor around muffle imbedded in ALUNDUM cement

**CRYSTOLON* CEMENT** — A silicon carbide product that is an excellent heat conductor and highly resistant to spalling, slag adherence and penetration. Especially suitable for lining and patching non-ferrous metal melting furnaces and laying brick in zinc and zinc oxide furnaces.

Pit furnaces lined with Norton CRYSTOLON cement

**MAGNORITE* CEMENT** — Electrically fused magnesia and one of the most refractory oxides commercially available. Has high resistance to basic slags and is recommended for lining induction furnaces in which refractory metals and alloys — ferrous and non-ferrous — are melted.



High frequency induction furnace lined with MAGNORITE cement

Norton refractory cements have been developed to meet a wide variety of metal-working processes involving the use and control of heat. A Norton refractories engineer will be glad to specify the right cements for your applications. NORTON COMPANY, Worcester 6, Mass.

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NORTON

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*Special REFRACTORIES*

*Making better products to make other products better*

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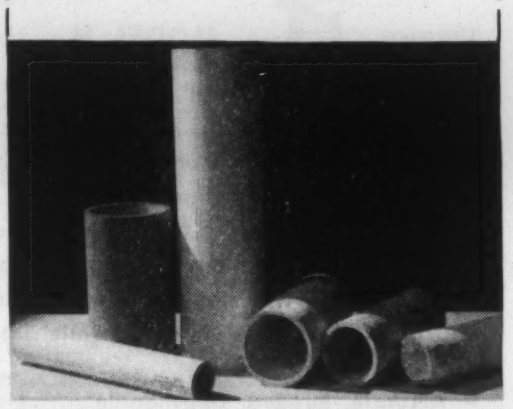
A. P. GREEN FIRE BRICK CO., Ltd. TORONTO, ONTARIO

## *For high temperature furnaces...* Super-Duty ALUNDUM Tubes

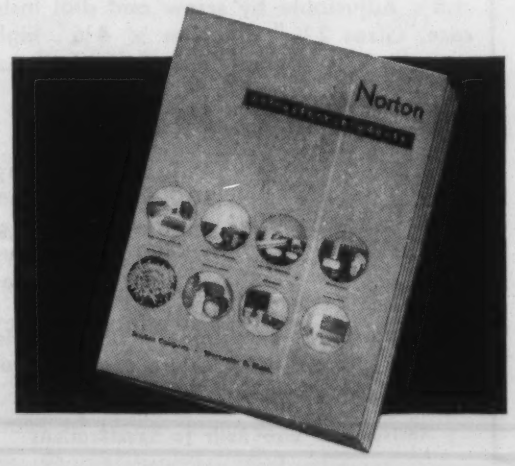


Norton keeps pace with steadily increasing temperatures in heat treating and sintering processes with a line of pure oxide refractories especially developed to withstand high heat.

Outstanding among these are ALUNDUM tubes (also cores and muffles) made of 99% fused alumina, providing excellent thermal conductivity and usable at temperatures up to 1950° C.

### *Norton Hearth Plates*

are of CRYSTOLON (silicon carbide), selected for this important use because of its high refractoriness and great mechanical strength. CRYSTOLON hearths help reduce the refractory bulk within the furnace and have aided in increasing continuous furnace operating time from 4 weeks to 18 months or longer.

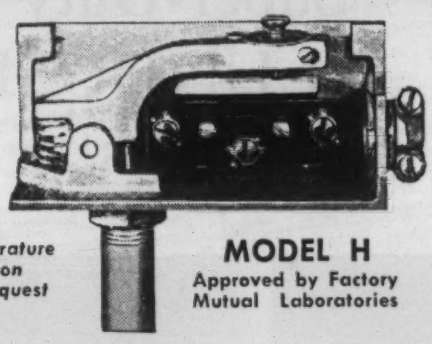



You'll find many helpful facts on Norton refractories, including bricks, burner blocks, cores and muffles in Bulletin 151. Write for it.

**NORTON COMPANY**
**346 NEW BOND STREET**
**WORCESTER 6, MASS.**

# BURLING
## TEMPERATURE LIMIT SWITCHES

**USE NO LIQUIDS . . . NO GASES**



*Literature on Request*

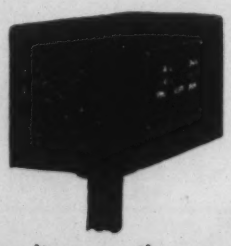
**MODEL H**
Approved by Factory Mutual Laboratories

**Improved High Temperature Safety Switch. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell—with single pole double throw switch . . . breaks heating circuit while closing alarm circuit.**

- **Accurate, Rugged, Dependable**
- **Corrosion and heat resisting tube**
- **Dial Pointer for easy setting inside case**
- **Locking screw locks temperature setting.**
- **Terminal plate has large screw terminals**
- **Snap-action Micro-Switch eliminates contact troubles**
- **Range minus 100° to 1400° F. Adjustable range 200 degrees**
- **Dimensions—5⅛" x 1¾" x 3"**

**MODEL V-1**

**For lower temperature range from 0-300° F. Available for minimum of—100° to maximum of 600° F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high.)**



**MODEL D**

**Adjustable range 200-500° F. Temperature range 0-1400° F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾".)**

**Instruments also Built to Specifications**

*Making Precision Controls for Over 14 Years*

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## Meetings and Expositions

AMERICAN ELECTROPLATERS' SOCIETY, annual convention. Buffalo. July 30-Aug. 2, 1951.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Seattle. Aug. 13-15, 1951.

AMERICAN CHEMICAL SOCIETY, diamond jubilee meeting. New York. Sept. 3-7, 1951.

ILLUMINATING ENGINEERING SOCIETY, national technical conference. Washington, D. C. Aug. 27-30, 1951.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor and production forum. Milwaukee. Sept. 10-13, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments & Regulators Div. and INSTRUMENT SOCIETY OF AMERICA, exhibit and joint conference. Houston. Sept. 10-14, 1951.

STEEL FOUNDERS' SOCIETY, fall meeting. Hot Springs, Va. Sept. 24-25, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Petroleum Mechanical Engineering conference. Tulsa. Sept. 24-26, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Minneapolis. Sept. 25-28, 1951.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual convention. Chicago. Oct. 1-4, 1951.

INDUSTRIAL PACKAGING & MATERIALS HANDLING EXPOSITION. Cleveland. Oct. 1-4, 1951.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Petroleum Branch fall meeting. Oklahoma City. Oct. 3-5, 1951.

PRESSED METAL INSTITUTE, annual meeting. Chicago. Oct. 3-6, 1951.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic, production forum and display. Los Angeles. Oct. 3-6, 1951.

PORCELAIN ENAMEL INSTITUTE, annual forum. Columbus, Ohio. Oct. 10-12, 1951.

ELECTROCHEMICAL SOCIETY, fall conference. Detroit. Oct. 10-13, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fuels and AIME Coal joint conference. Roanoke, Va. Oct. 10-11, 1951.

AMERICAN WELDING SOCIETY, annual meeting. Detroit. Oct. 14-20, 1951.

AMERICAN GAS ASSOCIATION, annual convention. St. Louis. Oct. 15-17, 1951.

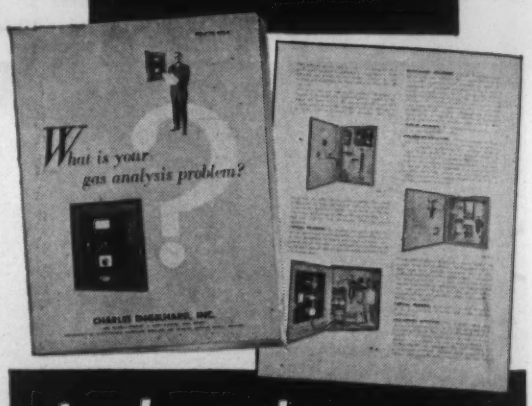
AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div. fall meeting. Detroit. Oct. 15-17, 1951.

AMERICAN SOCIETY FOR METALS, annual meeting. Detroit. Oct. 15-19, 1951.

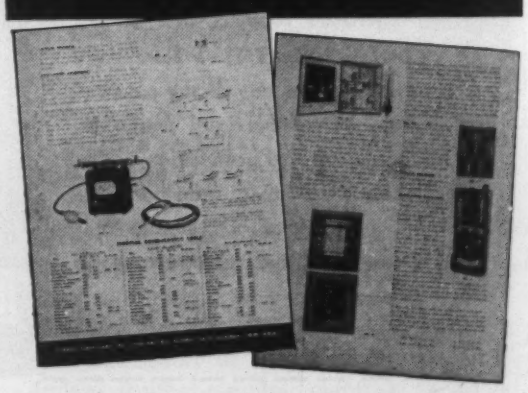
NATIONAL METAL CONGRESS & EXPOSITION. Detroit. Oct. 15-19, 1951.


# Want to know more about GAS ANALYSIS?

**Read this New 8-page ENGELHARD BULLETIN**




**Look at these Data • Packed Pages**



**YOU WILL FIND a wealth of material on a wide range of gas analysis problems and their solutions in the new Engelhard 8-page illustrated bulletin. It explains how Engelhard equipment provides complete, sensitive, accurate analyses by the proven thermal conductivity method. The bulletin also contains a *valuable thermal conductivity table* that you will want to keep for handy reference. *Write for your free copy today. Ask for Bulletin 800A.***

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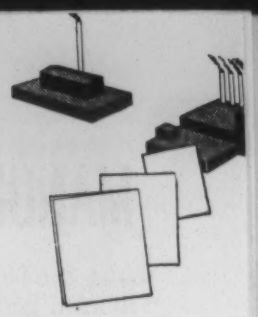

# MANUFACTURERS' LITERATURE

## Materials

### Irons • Steels

**Stainless Steel Design.** Allegheny Ludlum Steel Corp. Book discusses in detail applications of high tensile stainless steel in structural design. (1)

**Corrosion Resistant Steel.** Bethlehem Steel Co., 52 pp, ill, No. 269. Properties and characteristics of Mayari R low alloy, light, strong steel with high corrosion resistance. (2)

**Heat Resistant Steels.** Chicago Steel Foundry Co. Properties of Pyrasteel, chromium-nickel alloy designed for resistance to high temperatures, corrosive gasses and most commercial acids. (3)

**Steel Analyses Chart.** Globe Steel Tubes Co., No. 333. Tabulation of stainless steel analyses as produced by various manufacturers showing applications of each. (4)

**Gray Cast Iron.** Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (5)

**Free Machining Steel Plates.** W. J. Holliday & Co., Inc., 6 pp, ill, No. 901. Properties, characteristics and advantages of Speed Case and Speed Treat steel plates. Shows applications. (6)

**Stainless-Clad Steels.** Ingersoll Div. of Borg-Warner Corp. Folder describes IngAclad, 20% cladding of stainless steel bonded to backing of carbon steel. (7)

**Steel Data.** Joseph T. Ryerson & Son, Inc., 250 pp. Much helpful data on steel specifications and comparisons, tolerances, weight and a variety of other subjects. (8)

**Galvanized Steel.** Sharon Steel Corp. Brochure summarizes test data on Galvanite zinc coated steel said to fabricate like ordinary cold rolled steel, resist corrosion for years. (9)

**Graphitic Steel.** The Timken Roller Bearing Co., Steel & Tube Div. Data on properties and applications of graphitic steels in Timken Graphitic Steel Data Book. (10)

**Stainless Clad Steel.** Alan Wood Steel Co., No. D-97. Properties and applications of Permaclad stainless clad steel affording surface characteristics of stainless steel, formability of carbon steel. (11)

### Nonferrous Metals

**Aluminum By-Products.** Aluminum Co. of America, 4 pp, ill, No. AD-251. Describes company's research facilities and their part in the development of ceramic and gallium by-products. (12)

**Brass.** The American Brass Co., 4 pp, ill, No. B-39. Describes brass made by "Formbrite" process, said to give excellent fabricating properties, high tensile strength, hardness and ductility. (13)

**High Density Metal.** Fansteel Metallurgical Corp. Bulletin describes Fansteel 77 Metal, said to be strong, machinable, useful in rotors and balance weights, and has a density close to that of tungsten. (15)

**Silicon Bronzes.** Federated Metals Div., American Smelting and Refining Co., 4 pp, ill. Applications, typical properties and descriptions of high-strength silicon-copper alloys for casting. (16)

**Aluminum Alloy.** Frontier Bronze Corp. Data on Frontier 40-E aluminum alloy combining high strength, good shock and corrosion resistance and machinability. (17)

**Corrosion Resistance Computer.** H. M. Harper Co. Cardboard slide indicator enables rapid determination of proper nonferrous alloy or stainless steel for use with 142 corrosive agents. (18)

**Electrical Resistance Alloy.** The C. O. Jelliff Manufacturing Co. Engineering data on Jelliff Alloy 1000, said to have outstanding electrical and mechanical properties. (19)

**Aluminum Alloys.** Reynolds Aluminum Co., 12 pp, ill, No. AD104. Describes aluminum alloys, the forms in which they are available, and their uses. Includes tables of properties. (20)

**Nonferrous Alloy Specifications.** The Riverside Metal Co. Correlations of ASTM, Federal, Army and Navy Specifications for 40 nonferrous alloys. Includes characteristics, available forms and uses. (21)

**Ferro Alloys and Metals.** Vanadium Corp. of America, 24 pp, ill. *The Vancoram Review* presents technical articles on applications and developments in ferro metallurgy especially concerned with vanadium alloys. (22)

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### Nonmetallic Materials • Parts

**Porcelain Insulators.** The Akron Porcelain Co., 6 pp, ill. Numerous electrical insulators of various porcelains and brief description of engineering properties of porcelain. (23)

**Ceramic Parts Design.** American Lava Corp., 7 pp, ill, No. 144. Design tips on the best methods of designing steatite extruded and die-pressed parts. (24)

**Extruded Plastics.** The Anchor Plastics Co., 8 pp, ill, No. AP51. Shows numerous applications of extruded thermoplastics and brief characteristics to aid in selection. (25)

**Low Pressure Molding Material.** Bolta Products Sales, Inc., 4 pp, ill. Specifications, features and applications of Boltaron low-pressure molding material said to be exceptionally durable. (26)

**Bonding Resins.** Ciba Co., 4 pp, ill. Properties of new group of resins, their applications as adhesives for metals and nonmetallics, moldings and coatings. (27)

**Porcelain Products.** The Colonial Insulator Co., 12 pp, ill. Shows wide range of custom made porcelain products, including insulators, forms for dipped rubber goods, and kitchen appliances. (28)

**Coated Fabrics.** The Connecticut Hard Rubber Co. Uses, chemical, electrical and mechanical properties, and availability of heat resistant silicone rubber coated, glass fabrics. (29)

**Commercial Glass.** Corning Glass Works, No. B-83. "Properties of Selected Commercial Glasses" gives features of various types of glass and suggests industrial applications. (30)

**Plastics.** E. I. du Pont de Nemours & Co., (Inc.), 10 pp, ill, No. 113/3. Descriptions, advantages and uses of Lucite, Polythene Nylon, Butacite, Pyralin, Plastacele and Teflon. (31)

**Laminated Plastics Parts.** The Formica Co. Catalog gives full information on company's facilities for complete machining of Formica custom-made parts. (32)

**Polyvinyl Plastics.** B. F. Goodrich Chemical Co., 16 pp, ill. Properties and descriptions of Geon resins for such applications as extrusions, wire and cable, flooring and molded parts. (33)

**Rubber Reinforcing Resin.** Goodyear Tire & Rubber Co., Chemical Div., No. 601-B. Features and applications of Pliolite S-6B resin giving greater plasticity in rubber processing at low temperatures. (34)

**Plastics Molding.** P. R. Mallory & Co., Inc., 4 pp, ill. Complete production facil-

# MANUFACTURERS' LITERATURE

ities for large scale production of custom-molded parts from design to finishing and assembly. (35)

**Protective Covering.** Nox-Rust Chemical Corp. Booklet describes Vapor-Wrapper chemically treated paper said to protect metals against corrosion without use of oil or grease. (36)

**Alkyd Molding Compound.** Plaskon Div., No. A-3. Describes process for use in molding Plaskon Alkyd 420 (granular type) compounds, with data on mold construction, preforming and preheating. (37)

**Extruded and Molded Rubber Parts.** Republic Rubber Div., 12 pp, ill. Describes facilities for custom manufacture of molded and extruded rubber products. Describes various products. (38)

**Molded Parts.** Resistoflex Corp., 4 pp, ill, No. 4g/3. Properties and uses of this company's custom-molded parts and resinous-lined, reinforced industrial hose. (39)

**Molded and Laminated Plastics.** The Richardson Co., 4 pp, ill. Describes wide line of Insurok laminated and molded plastics products and facilities to design and fabricate them. (40)

**Carbon and Graphite Parts.** Stackpole Carbon Co., No. 40. Shows numerous standard parts and includes helpful data on the selection of carbon-graphite products. (42)

**Rubber Parts.** Stalwart Rubber Co., 16 pp, ill, No. 51SR-1. Describes applications and fabrication of rubber compounds designed to resist temperature, abrasion, chemicals and weathering. (43)

**Preformed Plastics.** F. J. Stokes Machine Co., ill, No. 509. Detailed properties of preformed plastics, pills, briquettes, or compacts said to be useful in accurate, less wasteful packing of molds. (44)

**Laminated Plastics.** Synthane Corp., 4 pp, ill. Military, government and other specifications of Synthane laminated plastics sheets, tubes and rods. (45)

**High Temperature Insulation.** H. I. Thompson Co., 34 pp, ill. Detailed technical data on Refrasil, giving case histories on performance characteristics as a high temperature insulator. (46)

**Rubber Parts.** Tyer Rubber Co., 4 pp, ill, No. 1c. Describes design and molding service for rubber parts specified by industry. (47)

**Carbon-Graphite Parts.** U. S. Graphite Co., 68 pp, ill, No. G-49. Properties, chemical resistance, limitations, assembly information, design aids and 60 applications of Graphitar. (48)

## Metal Parts • Forms

**Precision Castings.** The Adapti Co., Investment Casting Div. Brochure explains precision casting methods and shows by numerous applications how they are used. (49)

**Precision Castings.** Alloy Precision Castings Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts to order. Shows numerous products. (50)

**Aluminum Extruded Shapes.** Aluminum Co. of America, No. AD-229. Explains potentialities of extrusion process for aluminum to save money in fabrication operations. (51)

**Prefinished Metals.** American Nickeloid Co., 4 pp. Sampler shows finishes and platings available on zinc, steel, copper, brass and aluminum-base metals with actual samples. (52)

**Nonferrous Plaster Mold Castings.** Atlantic Casting & Engineering Corp., No. 4. Describes production of copper-base and aluminum alloy "Atlanticastings." (53)

**Welded Steel Tubing.** Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrication and specifications. (55)

**Steel Tubing.** Bundy Tubing Co., 20 pp, ill. Properties, specifications and typical parts of Bundyweld double-walled, copper-coated steel tubing. (56)

**Cemented Carbide Products.** Carboloy Co., 60 pp, ill, No. GT-250. Specifications and applications of this company's cemented carbide tools and blanks both standard and made to order. (57)

**Stainless Tubing.** Carpenter Steel Co., Alloy Tube Div., 4 pp, ill. Physical properties, corrosion resistance and available sizes of this company's stainless tubing. (58)

**Brass Wire Cloth.** Chase Brass & Copper Co. Lists mesh, diameter of wire, percent open area, weight and other data on complete line of company's brass and copper wire cloth. (59)

**Steel Castings.** Continental Foundry & Machine Co., 32 pp, ill. Booklet presents 12 considerations that should be taken into account in buying steel castings. (60)

**Stainless Valves.** The Cooper Alloy Foundry Co., 48 pp, ill. Catalog gives complete line of firm's stainless valves, fittings and accessories. Includes design information. (61)

**Forged Parts.** Drop Forging Assn., 60 pp. "Metal Quality" gives detailed data on the effects of hot working metals, describing properties obtained, advantages and limitations. (62)

**Aluminum Castings.** Eclipse-Pioneer Div. Foundries. "Book of Facts" discusses firm's facilities for producing aluminum, other nonferrous castings, describes advantages of casting. (63)

**Metal and Plastics Parts.** The Electric Auto-Lite Co., Bay Manufacturing Div., 16 pp, ill. Shows wide variety of custom-made ornamental and functional metal and plastics parts. (64)

**Corrosion Resistant Castings.** Electro-Alloys Div., American Brake Shoe Co., No. T-171. Properties and engineering uses of Chemalloy corrosion resistant alloys for casting. (65)

**Stainless Tubing.** Peter A. Frasse & Co., 12 pp. Data on machining seamless mechanical tubing, including recommendations for tool design. (66)

**Laminated Metals.** General Plate Div., Metals & Controls Corp., 4 pp, ill, No. 1a. Properties and uses of various laminated metals, including precious metals overlays and laminated silver contacts. (67)

**Precision Investment Castings.** Hitchiner Manufacturing Co. Technical and design data on costs, tooling, production and limitations of precision investment castings. (68)

**Die Castings.** The Hoover Co., 12 pp, ill, No. 853. Shows this company's facilities for producing zinc and aluminum die castings. Includes design helps, describes applications. (69)

**Iron and Steel Castings.** Hunt-Spiller Manufacturing Corp. Folder describes extensive facilities for production and finishing of iron and steel castings of any size and quantity. (70)

**Investment Castings.** Investment Casting Co., 12 pp, ill. "Investment Casting" describes process for precision casting of intricate close tolerance parts in difficult to machine metals and shows advantages. (71)

**Metal Rings.** King Fifth Wheel Co. Catalog and capacity charts of this company's facilities for bending and welding metal rings for industrial purposes. (72)

**Steel Castings.** Lebanon Steel Foundry. Data sheets give design aids for making good steel and alloy castings. Includes properties and chemical analyses of alloys. (73)

**Aluminum Extruded Shapes.** Light Metals Corp., 6 pp, ill. Shows facilities for producing to order a variety of indicated aluminum fabrications and extruded shapes. (74)

**Die Castings.** Litemetal Die Cast, Inc. 12 pp, ill. How to select best light metal for die casting. Shows facilities producing light metal pressure die castings. (75)

**Iron Castings.** Meehanite Metal Corp., 4 pp, ill, No. 32. Detailed tabular summary of physical properties of Meehanite high quality gray iron castings. (76)

**Powder Metal Parts.** Metal Powder Products, Inc., 2 pp, ill. Lists types of metal powder parts this company manufactures to order, their cost-saving advantages. (77)

**Ferrous Metal Forms.** Motors & Metals, Inc., 4 pp, ill. Shows stock of Meehanite metal forms such as rounds, tees, channels, angles, rings and bushings available from this company. (78)

**Precious Metals Parts.** The J. M. Ney Co., No. R-12. Technical data book describes this company's application of precious metal alloy to such components as elec-

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trical contacts, brushes and slip rings. (79)

**Precision Castings.** Ohio Precision Castings, Inc. Job study brochure on plaster mold precision casting applications made from brass, bronze, aluminum and beryllium copper. (80)

**Metal Powders.** Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom-making parts. (81)

**Powdered Metal Parts.** Powdered Metal Products Corp. of America. Catalog details powdered metal fabrication possibilities for such parts as gears, bearings, filters and self-lubricating bearings. (82)

**Powdered Metal Parts.** Radio Cores, Inc., 4 pp, ill. Describes this company's facilities for production of made-to-order powder metal parts of all types. (83)

**Metal Parts.** Edwin B. Stimpson Co., Inc., 40 pp, ill, No. 90. Illustrates complete line of small metal parts and fasteners, such as arrows and hands, parts for clothing, radios, etc., and ventilators. (85)

**Stainless Tubing.** Trent Tube Co. *Trentweld Data Bulletin* describes Trentweld stainless steel tubing, machine formed and welded in wide range of sizes. (86)

**Steel Castings.** Unitcast Corp., ill, No. 649-S. Discusses this company's testing facilities for insuring high quality production of steel castings. (87)

**Metal Powder Machine Parts.** The Wel-Met Co., 4 pp, ill. Numerous applications in which powder metallurgy proved a more economical method of producing parts than other methods. (88)

**Light Metal Shapes.** R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (89)

## Coatings • Finishes

**Phosphate Coating for Steel.** American Chemical Paint Co., 4 pp, ill. Describes method of meeting Government specifications for Grade I finish on steel using "Granodine". (90)

**Surface Coating Resins.** American Cyanamid Co. Properties, compatability and drying schedules of alkyd, formaldehyde, phenolic and dibasic acid resins for use in surface coatings. (91)

**Protective Coatings.** R. M. Hollingshead Corp., ill. Folder describes Klad Kote corrosion preventives, gives detailed specifications, uses, description and other data in tabular form. (92)

**Protective Coating.** Maas & Waldstein Co., No. 117. Technical data on Water Dip #33, protective coating for plated metal surfaces said to afford good oxidation protection. (93)

**Metallizing.** Metallizing Engineering Co., 6 pp, ill, Vol. 5, No. 8. Case histories describing time- and cost-saving salvage applications of metallizing. (94)

**Heat Resistant Finish.** Midland Industrial Finishes Co., 4 pp, ill. Numerous applications show effectiveness of Sicon, silicone-base finish with high stability under high temperatures. (95)

**Black Oxide Coating.** The Mitchell-Bradford Chemical Co., 4 pp, ill, No. MB-3. Six advantages of Black Magic (Type A) Black Oxide coating process for steel and iron. (96)

**Zinc Dust Paints.** New Jersey Zinc Co., 36 pp, ill. Characteristics and uses of zinc dust paints, most adherent paints for galvanized iron and sheet zinc. (97)

**Phosphate Coating for Steel.** Parker Rust Proof Co., 24 pp, ill, No. A-2511. Describes Parkerizing process for the protective coating of steel, its advantages and applications. (98)

# Methods and Equipment

## Heat Treating • Heating

**Heat Treating.** Ajax Electric Co., Inc., 906 Frankford Ave., Philadelphia, 72 pp, No. 116. Data on various methods of heat treating metals in this firm's salt bath furnaces. Request on company stationery.

**Controlled Atmosphere Furnaces.** Delaware Tool Steel Corp., 16 pp, ill. Constructional features and principle of operation of this firm's controlled atmosphere furnaces. (99)

**Induction Heating.** General Electric Co., GEA-4945. Case histories on the ways induction heating is being used to speed production of metal parts, cut costs. (100)

**Electrical Sintering Furnaces.** Harper Electric Furnace Corp., 2 pp, ill, No. 847. Construction features, operation and specifications of sintering furnaces for powder metals. (101)

**Oil Burner.** Hauck Manufacturing Co., 24 pp, ill, No. 410. Description and specifications of proportioning oil burner for such uses as batch and continuous heat treating furnaces. (102)

**Carburizing Nitriding Furnace.** Hevi Duty Electric Co., 28 pp, ill. Data on construction, features and operation of Hevi Duty Carburizer-Nitrider furnace. (103)

**Heat Treating Fixtures.** Hoskins Manufacturing Co. Catalog shows various heat treating fixtures, baskets, etc., made from heat resistant alloys. (104)

**High Frequency Heating Units.** Lepel High Frequency Laboratories, No. MM-7. Specifications, features and advantages of this company's low cost, high frequency heating units. (105)

**Induction Heating Units.** Lindberg Engineering Co., No. 1440. Descriptions and applications of this firm's induction heating units said to give rapid, dependable operation on large or small parts. (106)

**Refractories.** The Norton Co., No. 151. Data on this company's refractories, bricks, burner blocks, cores and muffles. (107)

**Ammonia Dissociators.** Sargeant & Wilbur, Inc., 4 pp, ill, No. A.D. 10. Features, specifications and applications of a variety of this company's ammonia dissociators. (108)

**Heat Treating Accessories.** Stanwood Corp., 16 pp, ill, No. 16. Describes variety of heat treating accessories, including baskets, retorts and carburizing boxes. (109)

**Dry Cyaniding Furnaces.** Surface Combustion Corp., 4 pp, ill, No. SC-145. Description, advantages and principle of dry (gas) cyaniding process showing this company's batch and continuous type furnaces. (110)

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**Gear-Hardening Machine.** Westinghouse Electric Corp., No. B-5259. Describes operation of radio frequency gear-hardening machine for hardening gears and shafts. (111)

## Cleaning • Finishing

**Buffing and Polishing Machine.** Acme Manufacturing Co. Descriptions and features of this firm's automatic buffing and polishing lathes for rapid finishing of parts in quantity. (113)

**Barrel Finishing.** Almco Div., Queen Stove Works, 20 pp, ill. Describes advanced barrel finishing process and equipment for controlled, close-tolerance finishes of metal parts. (114)

**Wet-Blasting Units.** The Cro-Plate Co., 4 pp, ill. Describes new line of wet-blasting units for high production deburring, descaling, stock removal and general finishing. (115)

**Cleaning Metal Surfaces.** Neilson Chemical Co. Data sheet describes this firm's products meeting government specifications for cleaning, rust removing, etching and protection of metals. (116)

**Metal Cleaners.** Oakite Products, Inc., 48 pp, ill. Booklet outlines all major cleaning methods for use on aircraft metals. Includes cleaning for anodizing, painting, spot welding and other purposes. (117)

**Tumbling Barrels.** Tumb-L-Matic, Inc., 2 pp, ill, No. LS-48. Features and specifications of Lupomatic dry process tumbling barrels for cutting down, deburring, burnishing metal and plastics parts. (118)

**Hard Chromium Plating Unit.** Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (119)

## Welding • Joining

**Bronze Welding Electrodes.** Ampco Metal, Inc., 24 pp, ill, No. W-17. Technical data on all of this company's bronze welding electrodes, plus recommended welding techniques and procedures to use. (120)

**Welding Design.** Eutectic Welding Alloys Corp., 40 pp, ill, No. 1. Manual gives detailed information on welding design, including joining methods, heating methods, technology and analyses of various joints. (121)

**Tungsten Electrodes.** Fansteel Metallurgical Corp., 4 pp, ill, No. 1.102-1. Describes tungsten electrodes said to be 99.9% pure. Includes specifications and directions for use. (122)

**Brazing.** Handy & Harman, ill, No. 54. *Brazing News* describes applications and developments of Easy-Flo and Sil-Fos low temperature silver brazing alloys. (123)

**Cold Headed Fasteners.** John Hassall, Inc., 34 pp, ill, No. 60. Explains cost savings available through use of cold headed fasteners. Shows complete line of nails, rivets, screws and other fasteners. (124)

**Solders.** Kester Solder Co., 28 pp, ill. Complete analysis of properties and applications of a variety of Flux Core soft solder alloys and soldering fluxes. (125)

**Argon Metal Arc Welding.** The Linde Air Products Co., 6 pp, ill, No. F-7416A. Procedures and equipment for argon metal arc welding, showing advantages and applications. (126)

**Adhesives, Coatings and Sealers.** Minnesota Mining and Manufacturing Co., 8 pp, ill, No. Z-SCPD. Illustrates typical applications of 3M adhesives, coatings and sealers to wide variety of uses. Includes table of properties. (127)

**Fastener.** New Process Screw Co. Bulletin describes Twin-fast screws for rapid fastening of wood to metals, plastics or other woods. (128)

**Induction Brazing.** The Ohio Crankshaft Co. "Typical Results of Tocco Induction Brazing and Soldering" shows by case histories the advantages of these fastening methods. (129)

**Weld Screws.** The Ohio Nut and Bolt Co. List of stock sizes of weld screws for spot and projection welding made of low carbon steel, brass or stainless steel. (130)

**Self-Locking Fasteners.** The Palnut Co., 1 p, ill. Describes self-locking machine screw Palnuts, coil tube fasteners, shield can fasteners and acorn Palnuts. (131)

**Bench Welder.** Raytheon Manufacturing Co., 2 pp, ill. Features, specifications and advantages of Raytheon bench welder claimed to enable precise welding by several methods. (132)

**Fasteners.** Simmons Fastener Corp. Literature describes fasteners especially designed for use in construction where easy demountability is required. (133)

**Carbon Arc Welding.** Speer Carbon Co., 8 pp, ill. Advantages of carbon arc welding for fabricating and repairing alloy and nonferrous metals. (134)

**Welding Procedure.** Stoody Co. Folder describes welding procedure for repairing metal parts such as top carrier rolls for tractor treads. (135)

**Weldments.** The Van Dorn Iron Works Co., ill. Information on advantages of weldments and this company's facilities for producing them. (136)

**Welding Positioners.** Worthington Pump and Machinery Corp. Bulletins describe Worthington-Ransome welding positioners with capacities ranging from 100 lb to 30 tons. (137)

## Forming • Casting • Molding Machining

**Plastics Molding Equipment.** Improved Paper Machinery Corp., 4 pp, ill. Features and advantages of Impco injection-compression, plunger, transfer and injection molding machines for plastics. (139)

**Die Casting Machines.** Kux Machine Co. Catalog shows complete line of die casting machines, including specifications and features. (140)

**Drilling Machines.** Wales-Strippit Corp., No. DM. Catalog describes features and specifications of new drilling machine permitting precise location, drilling and reaming of holes. (141)

**Magnetic Perforating Dies.** S. B. Whistler & Sons, Inc., ill. Complete descriptions and applications of thrs company's magnetic perforating dies. (142)

## Inspection • Testing • Control

**Metallograph.** Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (143)

**Specimen Cut-Off Machines.** Buehler Ltd. Describes complete line of metallurgical specimen cut-off machines available for

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**Pyrometers.** Claud S. Gordon Co., 4 pp, ill. Uses, applications and specifications of various pyrometers offering a complete line for high and low temperature indications. (145)

**Temperature Controls.** Illinois Testing Laboratories, Inc. Bulletin fully describes Alnor Pyrotac excess temperature cut-offs for maintaining proper processing temperatures. (146)

**Fatigue-Testing Machines.** Krouse Testing Machine Co., 10 pp, ill, No. 46-B. Describes company's plate and sheet fatigue testing machines, including specifications and testing data. (147)

**Compression Tester.** National Forge and Ordnance Co., 2 pp, ill, No. 492. Description, features and uses of sensitive, sturdy low-capacity-compression-crush testing machine. (148)

**X-ray Equipment.** Picker X-ray Corp., 8 pp, ill, No. 21250. Describes complete line of x-ray equipment from 50 kv to 24,000 kv. Includes complete accessories and protective equipment. (149)

**Universal Testing Machines.** Riehle Testing Machines Div., 6 pp, ill, No. RU-3-50. Features, specifications and descriptions of Model MA hydraulic universal testing machines. (150)

**Pyrometers.** Tagliabue Instruments Div., 34 pp, ill, No. 1101J. Detailed data on Celectray thermal indicating or recording controllers and accessories designed for high sensitivity and accuracy. (152)

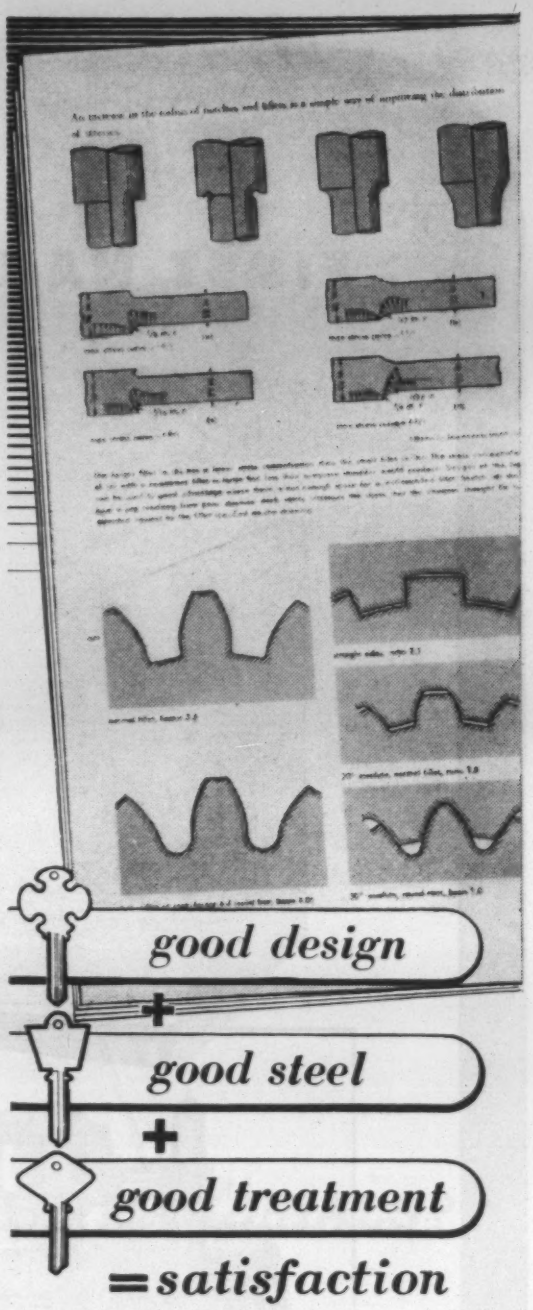
**Precision Hardness Tester.** Topflight Tool Co., Inc., 4 pp, ill. Describes automatic certifying hardness tester for high-speed testing of sheet metal parts. Includes operating instructions. (153)

**Hardness Testers.** Wilson Mechanical Instruments Co., 12 pp, ill, No. DH-114. Descriptions and specifications of several Tukon hardness testers. Includes discussion of hardness testing and applications. (154)

## General

**Stainless Steel Marking Process.** Ateenate, Inc., 4 pp, ill. Describes Ateenate process for permanently marking stainless steel. Shows numerous applications, gives specifications. (155)

**Materials Controls.** Remington Rand Inc., No. KD367. Booklet describes Kardex system for keeping visible materials and parts inventories coordinated with production. (156)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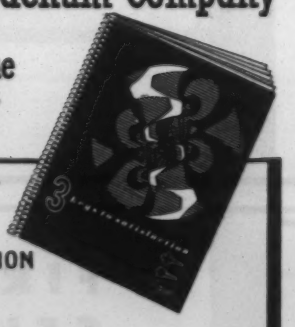

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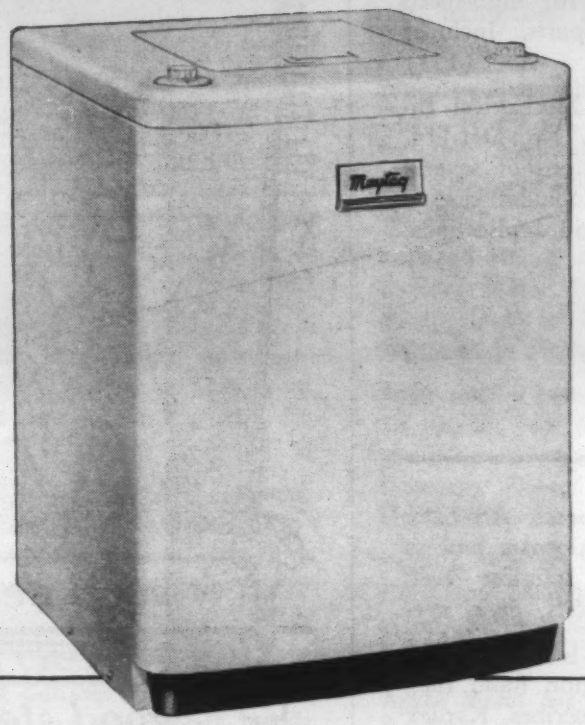

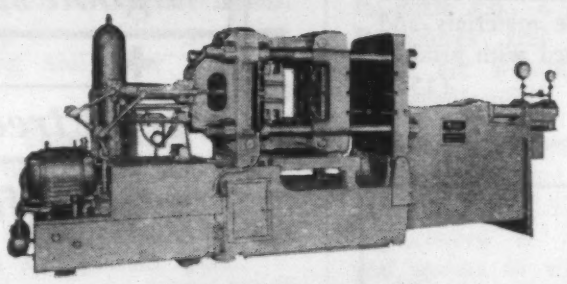

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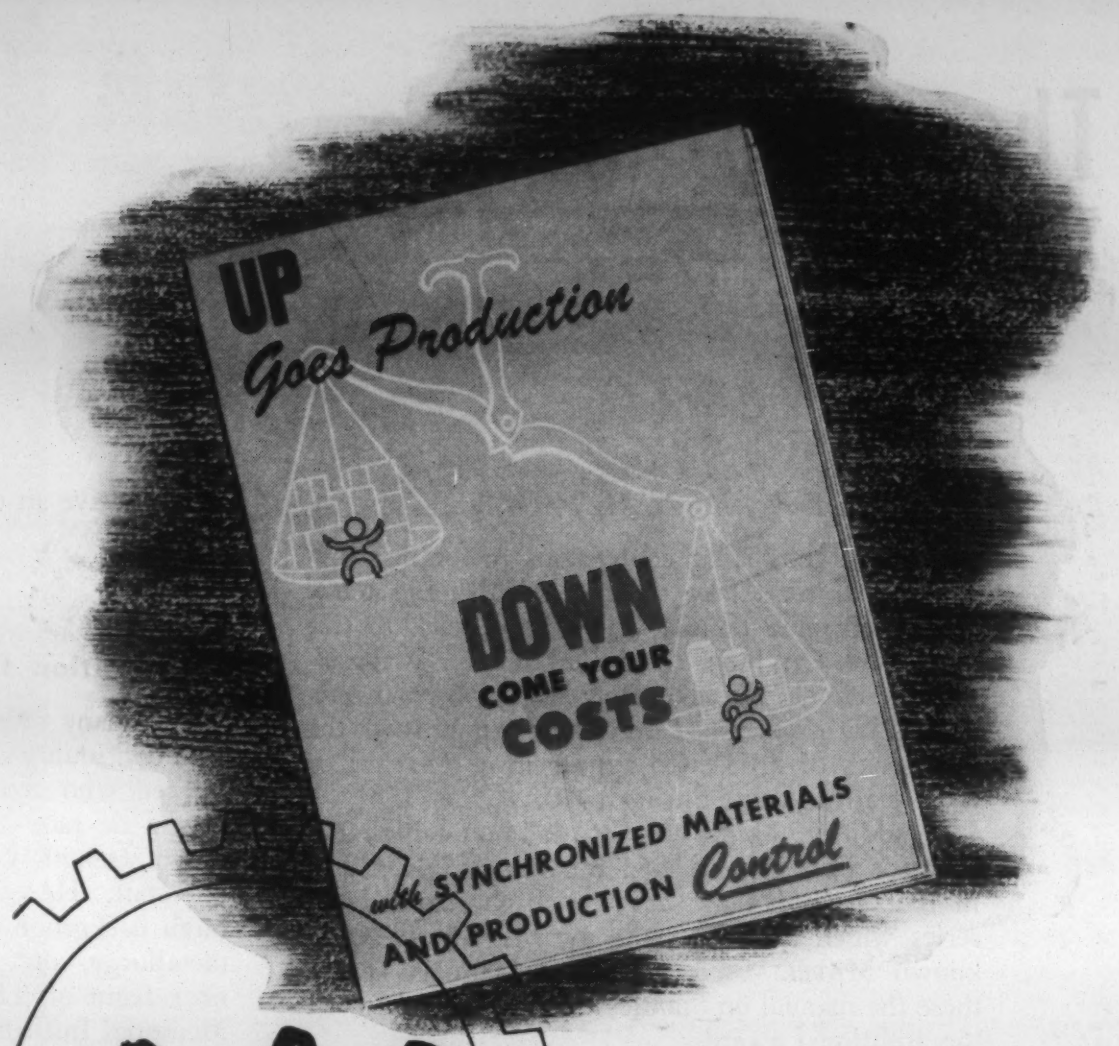


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# The Editor's Page

### May We Bow, Modestly?

Despite conflicting contentions re tooting your own horn, we'll take the risk of blushing while telling of some honors which have come to this magazine. On June 27 at New York's Waldorf-Astoria Hotel, MATERIALS & METHODS was presented with an award for having published the best series of articles to appear in a technical or industrial magazine during 1950.

In addition, M&M was awarded honorable mention for having published the best single article in that same period. As you might expect, the series which earned us the award was our well-known MATERIALS & METHODS Manuals. From these the manual on Stainless Steels was picked for the additional award.

The awards are sponsored by *Industrial Marketing Magazine;* and in the 13 years since the competition began, MATERIALS & METHODS and its predecessor, METALS AND ALLOYS, have earned 14 awards.

### The Welders' Choice

You unfortunate people who do not have television might well have one regret. If you haven't seen Dagmar you haven't lived. Our only reason for mentioning this is that recently Dagmar—I understand her real name is Jennie Lewis—was the center of attraction at ceremonies dedicating a new welding manufacturing center. It could be a case of two beautiful structures meeting each other face to face. The p.a.'s story said she had been chosen: "The girl we'd most like to weld with" by a group of welding men. Wanna bet?

### The Vanishing Engineer

More seriously, word has arrived that this country is more than 60,000 engineers short of the current demand. That estimate even takes into account the jobs filled by this June's graduates. By the looks of things now, the shortage is likely to continue for years to come. Perhaps the answer is to make engineering as glamorous as radio announcing or crooning. It seems that those occupations have an unending stream of candidates for jobs.

### An Addition to the Family

For many months now we have been engaged in a continuing contest with the Army to see who needed who among our editors most. Thus far it is a tie race—one in and one out. So to keep up to strength we have just added a new man to our staff. He is John Everhart, who has a thorough background in both ferrous and nonferrous metallurgy, and has worked as a materials engineer. Some of John's past connections are: Battelle Memorial Institute; National Bureau of Standards; Bethlehem Steel; American Smelting & Refining. Being from the Pennsylvania Dutch country, John naturally attended Lehigh University. In connection with his past occupations John has done considerable writing and decided to combine two interests by making writing his chief occupation and centering his attention upon materials. In some ways this is a 180-deg. turnabout, but we're pleased to have John with us and are sure that you readers will feel the same way.

### Bucket B———rs

With defense work and aircraft manufacture causing engineers to jump about with alacrity (and little sleep), there is increasing interest in a group founded during the latter part of World War II. Any one who has had to wrestle with the problems of turbine buckets is eligible to join the "Brotherhood of Bucket Bitchers".

Let's quote from the by-laws covering the local "Bucket Brigades": "Local chapters may vote with three members present, a fourth being necessary in case of a tie, and a 'fifth' being required in order to stagger through a design change. . . ."

Credit for founding this distinguished Brotherhood goes to Charley Brooks, of Austenal Laboratories, and Merrill Lemmon, of General Electric, who follow the rule that "a member must never be zygloed or x-rayed, because he is bound to be shown up as cracked".

**T. C. Du Mond**
**Editor**